

New CA Classifiers (random colours)

Wolfram Classes of ECAs

Functions for creating net and random datasets (ECAs, all 4 classes)

```

In[2]:= RandomRuleC[n_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[n, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]

netC[W_Integer, H_Integer] := NetInitialize@
  NetChain[{ConvolutionLayer[16, {2, 3}], Ramp, PoolingLayer[{H, W} - {1, 2}],
    FlattenLayer[], LinearLayer[256], SoftmaxLayer[]},
   "Input" -> NetEncoder[{"Image", {W, H}}],
   "Output" -> NetDecoder[{"Class", Range[0, 255]}]]

netTwoCC[W_Integer, H_Integer] := NetInitialize@
  NetChain[<|"conv1" -> ConvolutionLayer[16, {2, 3}], "ramp1" -> Ramp,
   "conv3" -> ConvolutionLayer[16, {2, 3}], "ramp2" -> Ramp,
   "pooling" -> PoolingLayer[{H, W} - {2, 4}], "flatten" -> FlattenLayer[],
   "linear" -> 512, "linear2" -> 4, "softmax" -> SoftmaxLayer[]|>,
   "Input" -> NetEncoder[{"Image", {W, H}}],
   "Output" -> NetDecoder[{"Class", Range[1, 4]}]]

dataC[W_Integer, H_Integer, n_Integer] := Table[
  RandomRuleC[i, W, H] -> CAclasses[[i + 1]], {i, RandomChoice[Range[0, 255], n]}]

```

```
In[6]:= netThreeCC[W_Integer, H_Integer] :=
NetInitialize@NetChain[<|"conv1" → ConvolutionLayer[16, {2, 3}],
 "ramp1" → Ramp, "conv2" → ConvolutionLayer[16, {2, 3}],
 "ramp2" → Ramp, "conv3" → ConvolutionLayer[16, {2, 3}], "ramp3" → Ramp,
 "pooling" → PoolingLayer[{H, W} - {4, 8}], "flatten" → FlattenLayer[],
 "linear" → 512, "linear2" → 4, "softmax" → SoftmaxLayer[]|>,
 "Input" → NetEncoder[{"Image", {W, H}}],
 "Output" → NetDecoder[{"Class", Range[1, 4]}]]
```

```
In[7]:= netThreeCC1024[W_Integer, H_Integer] :=
NetInitialize@NetChain[<|"conv1" → ConvolutionLayer[16, {2, 3}],
 "ramp1" → Ramp, "conv2" → ConvolutionLayer[16, {2, 3}],
 "ramp2" → Ramp, "conv3" → ConvolutionLayer[16, {2, 3}], "ramp3" → Ramp,
 "pooling" → PoolingLayer[{H, W} - {4, 8}], "flatten" → FlattenLayer[],
 "linear" → 1024, "linear2" → 4, "softmax" → SoftmaxLayer[]|>,
 "Input" → NetEncoder[{"Image", {W, H}}],
 "Output" → NetDecoder[{"Class", Range[1, 4]}]]
```

```
In[8]:= netFourCC512[W_Integer, H_Integer] :=
NetInitialize@NetChain[<|"conv1" → ConvolutionLayer[32, {2, 3}],
 "ramp1" → Ramp, "conv3" → ConvolutionLayer[32, {2, 3}], "ramp2" → Ramp,
 "pooling" → PoolingLayer[{H, W} - {2, 4}], "flatten" → FlattenLayer[],
 "linear" → 512, "linear2" → 4, "softmax" → SoftmaxLayer[]|>,
 "Input" → NetEncoder[{"Image", {W, H}}],
 "Output" → NetDecoder[{"Class", Range[1, 4]}]]
```

```
In[9]:= netFiveCC512[W_Integer, H_Integer] :=
NetInitialize@NetChain[<|"conv1" → ConvolutionLayer[32, {2, 3}],
 "bat1" → BatchNormalizationLayer[], "ramp1" → Ramp,
 "conv3" → ConvolutionLayer[32, {2, 3}],
 "bat2" → BatchNormalizationLayer[], "ramp2" → Ramp,
 "pooling" → PoolingLayer[{H, W} - {2, 4}], "flatten" → FlattenLayer[],
 "linear" → 512, "linear2" → 4, "softmax" → SoftmaxLayer[]|>,
 "Input" → NetEncoder[{"Image", {W, H}}],
 "Output" → NetDecoder[{"Class", Range[1, 4]}]]
```

```
In[10]:= netSixCC512drop[W_Integer, H_Integer] :=
NetInitialize@NetChain[<|"drop1" → DropoutLayer[0.2], "conv1" →
ConvolutionLayer[32, {3, 3}], "bat1" → BatchNormalizationLayer[],
 "ramp1" → Ramp, "conv3" → ConvolutionLayer[32, {3, 3}],
 "bat2" → BatchNormalizationLayer[], "ramp2" → Ramp,
 "pooling" → PoolingLayer[{H, W} - {4, 8}], "flatten" → FlattenLayer[],
 "linear" → 512, "drop2" → DropoutLayer[0.2], "linear2" → 4,
 "softmax" → SoftmaxLayer[]|>, "Input" → NetEncoder[{"Image", {W, H}}],
 "Output" → NetDecoder[{"Class", Range[1, 4]}]]
```

```
In[1]:= netSevenCC512drop[W_Integer, H_Integer] :=
NetInitialize@NetChain[<|"conv1" → ConvolutionLayer[24, {3, 3}],
"bat1" → BatchNormalizationLayer[], "ramp1" → Ramp,
"conv3" → ConvolutionLayer[24, {3, 3}],
"bat2" → BatchNormalizationLayer[], "ramp2" → Ramp,
"pooling" → PoolingLayer[{H, W} - {4, 8}], "flatten" → FlattenLayer[],
"linear" → 512, "drop2" → DropoutLayer[0.2], "linear2" → 4,
"softmax" → SoftmaxLayer[]|>, "Input" → NetEncoder[{"Image", {W, H}}],
"Output" → NetDecoder[{"Class", Range[1, 4]}]]
```

```
In[12]:= netEightCC512drop[W_Integer, H_Integer] :=
NetInitialize@NetChain[<|"conv1" → ConvolutionLayer[24, {3, 3}],
"bat1" → BatchNormalizationLayer[], "ramp1" → Ramp,
"conv2" → ConvolutionLayer[16, {2, 3}], "bat2" → BatchNormalizationLayer[],
"ramp2" → Ramp, "conv3" → ConvolutionLayer[24, {3, 3}],
"bat3" → BatchNormalizationLayer[], "ramp3" → Ramp,
"pooling" → PoolingLayer[{H, W} - {8, 16}], "flatten" → FlattenLayer[],
"linear" → 1024, "drop2" → DropoutLayer[0.2], "linear2" → 4,
"softmax" → SoftmaxLayer[]|>, "Input" → NetEncoder[{"Image", {W, H}}],
"Output" → NetDecoder[{"Class", Range[1, 4]}]]
```

```
In[13]:= netNineCC512drop[W_Integer, H_Integer] :=
NetInitialize@NetChain[<|"conv1" → ConvolutionLayer[24, {3, 3}],
"bat1" → BatchNormalizationLayer[], "ramp1" → Ramp,
"conv2" → ConvolutionLayer[24, {3, 3}], "bat2" → BatchNormalizationLayer[],
"ramp2" → Ramp, "conv3" → ConvolutionLayer[24, {3, 3}],
"bat3" → BatchNormalizationLayer[], "ramp3" → Ramp,
"pooling" → PoolingLayer[{H, W} - {12, 12}], "flatten" → FlattenLayer[],
"linear" → 512, "drop2" → DropoutLayer[0.2], "linear2" → 4,
"softmax" → SoftmaxLayer[]|>, "Input" → NetEncoder[{"Image", {W, H}}],
"Output" → NetDecoder[{"Class", Range[1, 4]}]]
```

```
In[14]:= netTenCC1024drop[W_Integer, H_Integer] :=
NetInitialize@NetChain[<|"conv1" → ConvolutionLayer[24, {3, 3}],
"bat1" → BatchNormalizationLayer[], "ramp1" → Ramp,
"conv2" → ConvolutionLayer[24, {3, 3}], "bat2" → BatchNormalizationLayer[],
"ramp2" → Ramp, "conv3" → ConvolutionLayer[24, {3, 3}],
"bat3" → BatchNormalizationLayer[], "ramp3" → Ramp,
"conv4" → ConvolutionLayer[24, {3, 3}],
"bat4" → BatchNormalizationLayer[], "ramp4" → Ramp,
"pooling" → PoolingLayer[{H, W} - {12, 12}], "flatten" → FlattenLayer[],
"linear" → 1024, "drop2" → DropoutLayer[0.3], "linear2" → 4,
"softmax" → SoftmaxLayer[]|>, "Input" → NetEncoder[{"Image", {W, H}}],
"Output" → NetDecoder[{"Class", Range[1, 4]}]]
```

```
In[15]:= netElevenCC1024drop[W_Integer, H_Integer] :=
  NetInitialize@NetChain[<|"conv1" → ConvolutionLayer[48, {3, 3}],
    "bat1" → BatchNormalizationLayer[], "ramp1" → Ramp,
    "pooling1" → PoolingLayer[{2, 2}], "conv2" → ConvolutionLayer[24, {3, 3}],
    "bat2" → BatchNormalizationLayer[], "ramp2" → Ramp,
    "pooling2" → PoolingLayer[{2, 2}], "conv3" → ConvolutionLayer[24, {3, 3}],
    "bat3" → BatchNormalizationLayer[], "ramp3" → Ramp,
    "pooling3" → PoolingLayer[{2, 2}], "conv4" → ConvolutionLayer[12, {3, 3}],
    "bat4" → BatchNormalizationLayer[], "ramp4" → Ramp,
    "pooling4" → PoolingLayer[{2, 2}], "flatten" → FlattenLayer[],
    "linear" → 1024, "drop2" → DropoutLayer[0.3], "linear2" → 4,
    "softmax" → SoftmaxLayer[]|>, "Input" → NetEncoder[{"Image", {W, H}}],
    "Output" → NetDecoder[{"Class", Range[1, 4]}]]
```

Functions for creating datasets (1D totalistic CAs)

k=3, r=1 totalistic (class 4 only)

```
In[16]:= gen3TC[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {3, 1}}, RandomInteger[1, W], H - 1],
    ImageSize → {W, H}, ColorRules → {0 → RandomColor[], 1 → RandomColor[],
      3 → RandomColor[], 4 → RandomColor[], 5 → RandomColor[],
      6 → RandomColor[], 7 → RandomColor[]}, Frame → False]]
data3T2C[W_Integer, H_Integer, n_Integer] := Table[gen3TC[i, W, H] → 4,
  {i, RandomChoice[{1635, 1815, 2007, 2043, 2049, 1388, 1041}], n}]
```

k=4, r=1 totalistic (class 4 only, 1 example)

```
In[18]:= gen4TC[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {4, 1}}, RandomInteger[1, W], H - 1],
    ImageSize → {W, H}, ColorRules → {0 → RandomColor[], 1 → RandomColor[],
      3 → RandomColor[], 4 → RandomColor[], 5 → RandomColor[],
      6 → RandomColor[], 7 → RandomColor[]}, Frame → False]]
data4TC[W_Integer, H_Integer, n_Integer] := Table[gen4TC[1004600, W, H] → 4, n]
```

k=2, r=2 totalistic (all 4 classes)

```
In[20]:= gen2r2C[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {2, 1}, 2}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
data2r2c4C[W_Integer, H_Integer, n_Integer] :=
  Table[gen2r2C[i, W, H] -> 4, {i, RandomChoice[{20, 52}, n]}]
data2r2c3C[W_Integer, H_Integer, n_Integer] :=
  Table[gen2r2C[i, W, H] -> 3, {i, RandomChoice[
    {2, 6, 10, 12, 14, 18, 22, 26, 28, 30, 34, 38, 42, 44, 46, 50}, n]}]
data2r2c2C[W_Integer, H_Integer, n_Integer] :=
  Table[gen2r2C[i, W, H] -> 2, {i, RandomChoice[{8, 24, 56}, n]}]
data2r2c1C[W_Integer, H_Integer, n_Integer] := Table[gen2r2C[i, W, H] -> 1,
  {i, RandomChoice[{0, 4, 16, 32, 36, 40, 48, 54, 58, 60, 62}, n]}]
genData2r2C[W_Integer, H_Integer, n_Integer] := Join[data2r2c4C[W, H, n],
  data2r2c3C[W, H, n], data2r2c2C[W, H, n], data2r2c1C[W, H, n]]
```

k=5, r=1 totalistic (class 4 only)

```
In[26]:= gen5T4C[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {5, 1}}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
data5T4C[n_Integer, W_Integer, H_Integer] :=
  Table[gen5T4C[i, W, H] -> 4, {i, RandomChoice[
    {781 130 654, 772 514 435, 1 151 319 452, 309 095 787, 880 862 046, 973 835 714,
      779 446 817, 345 466 505, 535 500 975, 793 363 571, 1 052 373 865, 455 984 785,
      339 227 109, 1 050 973 846, 513 368 817, 91 315 820, 113 925 357}, n]}]
```

k=5, r=1 totalistic (classes 2/3/4)

```
In[28]:= gen5TC[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {5, 1}, 1}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
data5T4CC[W_Integer, H_Integer, n_Integer] := Table[gen5TC[i, W, H] -> 4,
  {i, RandomChoice[{644 218 533, 491 739 943, 6 889 640, 986 144 962, 1 099 816 682,
    988 971 204, 300 829 994, 272 622 024, 304 100 638, 626 595 633}, n]}]
data5T3CC[W_Integer, H_Integer, n_Integer] := Table[gen5TC[i, W, H] -> 3,
  {i, RandomChoice[{889 082 395, 541 068 260, 807 907 479, 816 180 062, 650 485 139,
    643 827 745, 753 940 864, 871 525 323, 351 440 311, 83 501 460}, n]}]
data5T2CC[W_Integer, H_Integer, n_Integer] :=
  Table[gen5TC[i, W, H] -> 2, {i, RandomChoice[
    {525 735 659, 1 022 330 944, 1 007 796 739, 495 633 437, 1 036 827 943}, n]}]
genData5TCC[W_Integer, H_Integer, n_Integer] :=
  Join[data5T4CC[W, H, n], data5T3CC[W, H, n], data5T2CC[W, H, n]]
```

Generate test datasets

k=2, r=2 non-totalistic

```
In[33]:= genk2r2C[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, 2, 2}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
datak2r2C[W_Integer, H_Integer, n_Integer] :=
  Table[genk2r2C[i, W, H] -> i, {i, RandomChoice[Range[0, 4 294 967 295], n]}]
```

k=2, r=3 non-totalistic

```
In[35]:= genk2r3NT[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, 2, 3}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
datak2r3NT[W_Integer, H_Integer, n_Integer] :=
  Table[genk2r3NT[i, W, H] -> i, {i, RandomInteger[2^2^7 - 1, n]}]
```

k=3, r=1 non-totalistic

```
In[37]:= genk3r1NT[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, 3}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
datak3r1NT[W_Integer, H_Integer, n_Integer] :=
  Table[genk3r1NT[i, W, H] -> i, {i, RandomInteger[3^3^3 - 1, n]}]
```

k=3, r=2 totalistic

```
In[39]:= genk3r2C[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {3, 1}, 2}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
datak3r2C[W_Integer, H_Integer, n_Integer] :=
  Table[genk3r2C[i, W, H] -> i, {i, RandomChoice[Range[0, 177146], n]}]
```

k=3, r=3 totalistic

```
In[41]:= genk3r3C[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {3, 1}, 3}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
datak3r3C[W_Integer, H_Integer, n_Integer] :=
  Table[genk3r3C[i, W, H] -> i, {i, RandomChoice[Range[0, 14348906], n]}]
```

k=4, r=1 non-totalistic

```
In[43]:= genk4r1NT[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, 4}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
datak4r1NT[W_Integer, H_Integer, n_Integer] :=
  Table[genk4r1NT[i, W, H] -> i, {i, RandomInteger[4^4^3 - 1, n]}]
```

k=4, r=1 totalistic

```
In[45]:= genk4r1C[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {4, 1}}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
datak4r1C[W_Integer, H_Integer, n_Integer] :=
  Table[genk4r1C[i, W, H] -> i, {i, RandomChoice[Range[0, 1048575], n]}]
```

k=4, r=2 totalistic

```
In[47]:= genk4r2C[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {4, 1}, 2}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
datak4r2C[W_Integer, H_Integer, n_Integer] :=
  Table[genk4r2C[i, W, H] -> i, {i, RandomChoice[Range[0, 4294967295], n]}]
```

k=5, r=1 totalistic

```
In[49]:= gen5T2C[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {5, 1}, 1}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
data5T2C[n_Integer, W_Integer, H_Integer] := Table[gen5T2C[i, W, H] -> i,
  {i, RandomChoice[Range[0, 1220703125], n]}]
```

k=6, r=1 totalistic

```
In[51]:= gen6TC[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {6, 1}, 1}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
data6TC[n_Integer, W_Integer, H_Integer] := Table[gen6TC[i, W, H] -> i,
  {i, RandomInteger[2821109907455, n]}]
```

k=6, r=2 totalistic

```
In[3989]:= gen6T2C[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {6, 1}, 2}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
data6T2C[n_Integer, W_Integer, H_Integer] := Table[gen6T2C[i, W, H] -> i,
  {i, RandomInteger[170 581 728 179 578 208 255, n]}]
```

k=6, r=3 totalistic

```
In[3987]:= gen6T3C[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {6, 1}, 3}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
data6T3C[n_Integer, W_Integer, H_Integer] := Table[gen6T3C[i, W, H] -> i,
  {i, RandomInteger[10 314 424 798 490 535 546 171 949 055, n]}]
```

In[3984]:= 6^(1 + (5 * 7))

Out[3984]= 10 314 424 798 490 535 546 171 949 056

k=7, r=1 totalistic

```
In[55]:= gen7TC[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {7, 1}, 1}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
data7TC[n_Integer, W_Integer, H_Integer] := Table[gen7TC[i, W, H] -> i,
  {i, RandomInteger[11 398 895 185 373 142, n]}]
```

k=8, r=1 totalistic

```
In[57]:= gen8TC[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {8, 1}, 1}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
data8TC[n_Integer, W_Integer, H_Integer] := Table[gen8TC[i, W, H] -> i,
  {i, RandomInteger[73 786 976 294 838 206 463, n]}]
```

k=8, r=2 totalistic

```
In[59]:= gen8T2C[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {8, 1}, 2}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[]}, Frame -> False]]
data8T2C[n_Integer, W_Integer, H_Integer] := Table[gen8T2C[i, W, H] -> i,
  {i, RandomInteger[324 518 553 658 426 726 783 156 020 576 255, n]}]
```

k=9, r=1 totalistic

```
In[61]:= gen9TC[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {9, 1}, 1}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[], 8 -> RandomColor[]}, Frame -> False]]
data9TC[n_Integer, W_Integer, H_Integer] := Table[gen9TC[i, W, H] -> i,
  {i, RandomInteger[717 897 987 691 852 588 770 248, n]}]
```

k=10, r=1 totalistic

```
In[1418]:= gen10TC[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {10, 1}, 1}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[], 3 ->
      RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[], 6 -> RandomColor[],
      7 -> RandomColor[], 8 -> RandomColor[], 9 -> RandomColor[]}, Frame -> False]]
data10TC[n_Integer, W_Integer, H_Integer] := Table[gen10TC[i, W, H] -> i,
  {i, RandomInteger[9 999 999 999 999 999 999 999 999 999, n]}]
```

k=11, r=1 totalistic

```
In[1446]:= gen11TC[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {11, 1}, 1}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[],
      3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[],
      6 -> RandomColor[], 7 -> RandomColor[], 8 -> RandomColor[],
      9 -> RandomColor[], 10 -> RandomColor[]}, Frame -> False]]
data11TC[n_Integer, W_Integer, H_Integer] := Table[gen11TC[i, W, H] -> i,
  {i, RandomInteger[191 943 424 957 750 480 504 146 841 291 809, n]}]
```

k=13, r=1 totalistic

```
In[2882]:= gen13TC[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {13, 1}, 1}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[], 2 -> RandomColor[], 3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[], 6 -> RandomColor[], 7 -> RandomColor[], 8 -> RandomColor[], 9 -> RandomColor[], 10 -> RandomColor[], 11 -> RandomColor[], 12 -> RandomColor[]}, Frame -> False]]
data13TC[n_Integer, W_Integer, H_Integer] := Table[gen13TC[i, W, H] -> i,
  {i, RandomInteger[164 400 841 185 494 513 395 503 358 052 498 933 338 332, n]}]
```

k=18, r=1 totalistic

```
In[1448]:= gen18TC[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {18, 1}, 1}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[], 2 -> RandomColor[], 3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[], 6 -> RandomColor[], 7 -> RandomColor[], 8 -> RandomColor[], 9 -> RandomColor[], 10 -> RandomColor[], 11 -> RandomColor[], 12 -> RandomColor[], 13 -> RandomColor[], 14 -> RandomColor[], 15 -> RandomColor[], 16 -> RandomColor[], 17 -> RandomColor[]}, Frame -> False]]
data18TC[n_Integer, W_Integer, H_Integer] :=
  Table[gen18TC[i, W, H] -> i, {i, RandomInteger[
    188 005 374 836 229 120 894 273 278 138 806 956 375 747 747 317 139 671 689 960 882 175
    , n]}]
```

k=18, r=2 totalistic

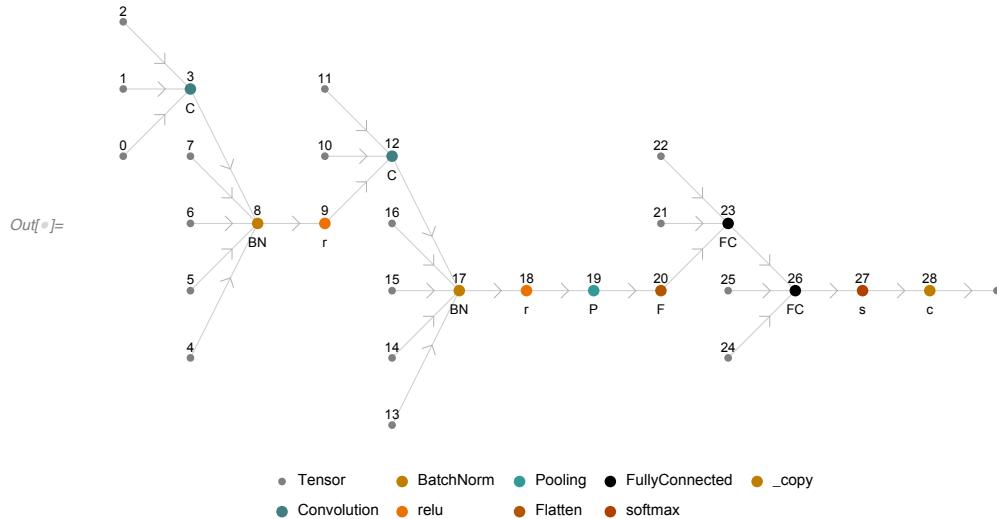
```
In[1520]:= gen18TC2[p_Integer, W_Integer, H_Integer] :=
  Image[ArrayPlot[CellularAutomaton[{p, {18, 1}, 2}, RandomInteger[1, W], H - 1],
    ImageSize -> {W, H}, ColorRules -> {0 -> RandomColor[], 1 -> RandomColor[], 2 -> RandomColor[], 3 -> RandomColor[], 4 -> RandomColor[], 5 -> RandomColor[], 6 -> RandomColor[], 7 -> RandomColor[], 8 -> RandomColor[], 9 -> RandomColor[], 10 -> RandomColor[], 11 -> RandomColor[], 12 -> RandomColor[], 13 -> RandomColor[], 14 -> RandomColor[], 15 -> RandomColor[], 16 -> RandomColor[], 17 -> RandomColor[]}, Frame -> False]]
data18TC2[n_Integer, W_Integer, H_Integer] :=
  Table[gen18TC2[i, W, H] -> i, {i, RandomInteger[
    898 329 039 328 569 654 470 595 577 351 525 582 031 758 425 960 393 515 924 678 757
    , 649 705 312 264 544 347 400 389 737 771 882 648 094 900 223, n]}]
```

Network XIII - Two convolutions, dropout on linear only, BatchNorm

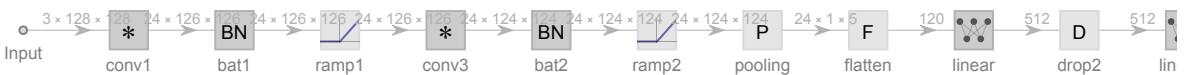
```
In[1]:= netECA13 = netSevenCC512drop[128, 128]
```

Out[1]= NetChain[ Input port: image
Output port: class
Number of layers: 12]

```
In[2]:= NetInformation[netECA13, "MXNetNodeGraphPlot"]
```



```
In[3]:= NetInformation[netECA13, "SummaryGraphic"]
```

Out[3]= 

```
In[4]:= dataECA13 = dataC[128, 128, 8192];
```

```
In[5]:= dataTotalistic2BigC13 = genData2r2C[128, 128, 1024];
```

```
In[6]:= dataTotalistic3BigC13 = data3T2C[128, 128, 1024];
```

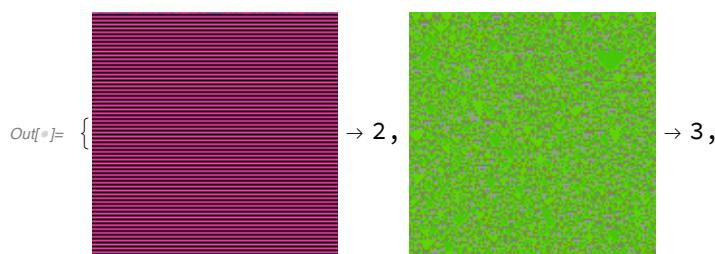
```
In[7]:= dataTotalistic4BigC13 = data4TC[128, 128, 1024];
```

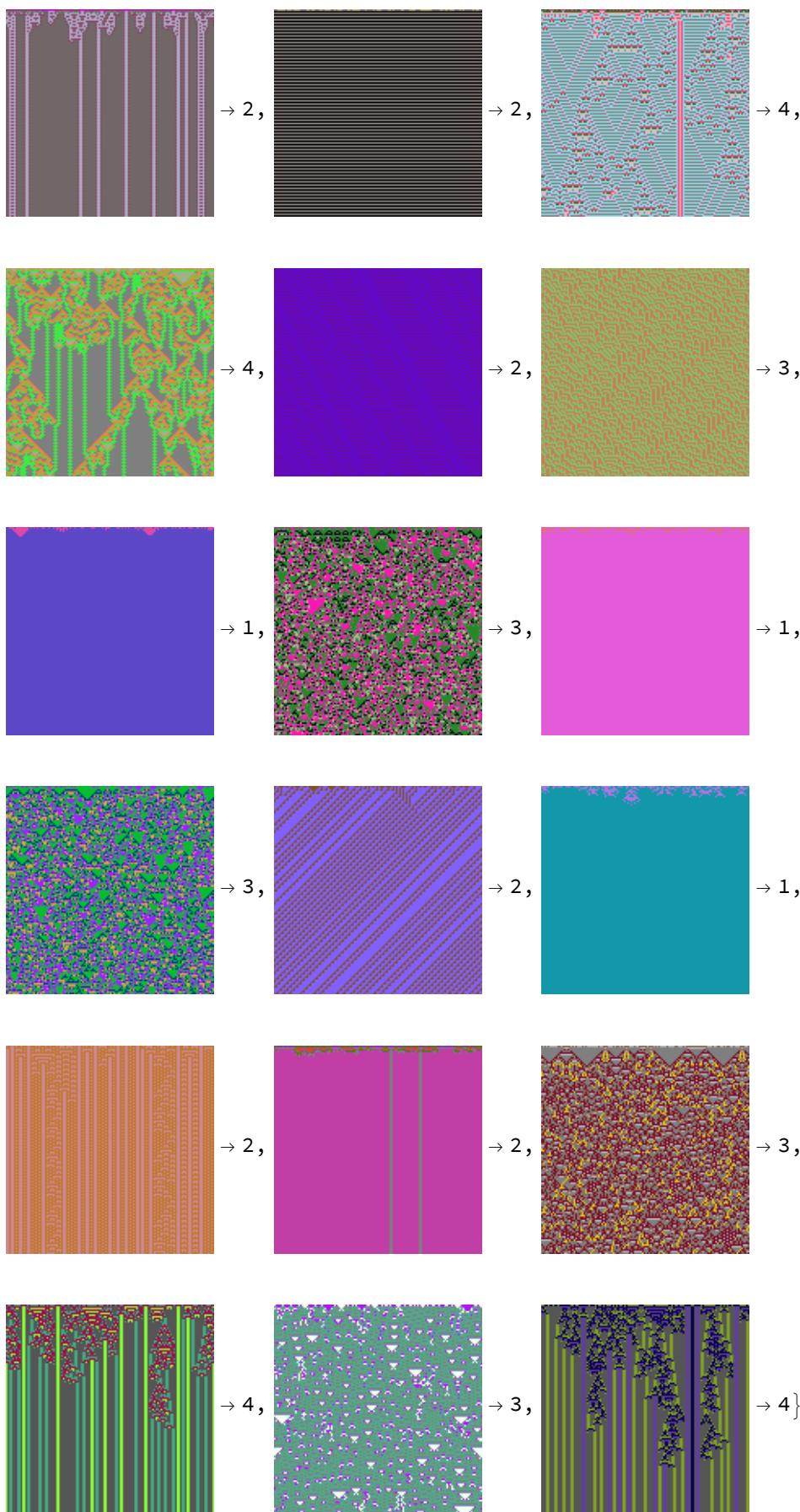
```
In[8]:= dataTotalistic5BigC13 = genData5TCC[128, 128, 4096];
```

```
In[9]:= fullTrainingBigC13 = Join[dataECA13, dataTotalistic2BigC13,  
dataTotalistic3BigC13, dataTotalistic4BigC13, dataTotalistic5BigC13];  
Length[fullTrainingBigC13]
```

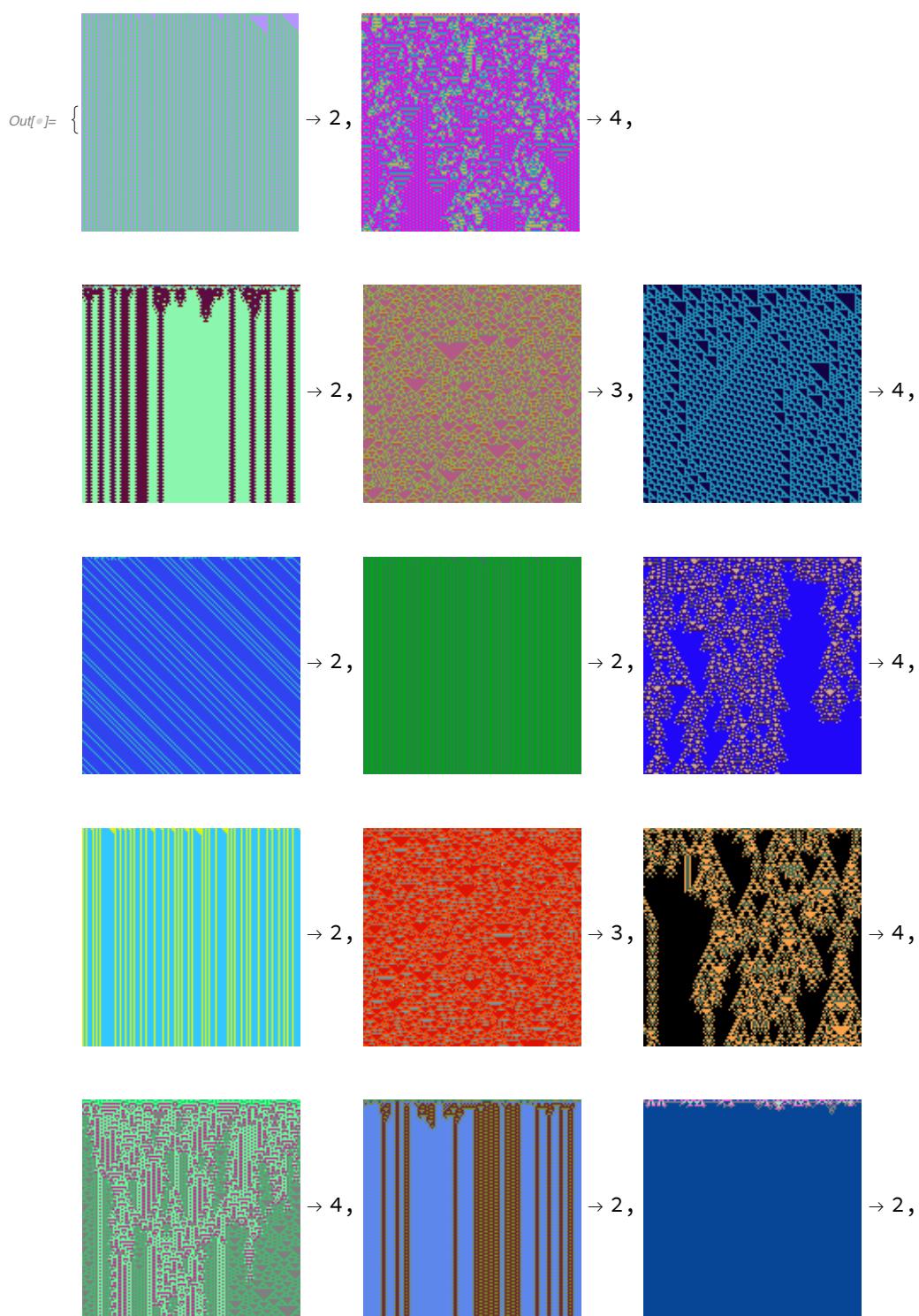
Out[9]= 26 624

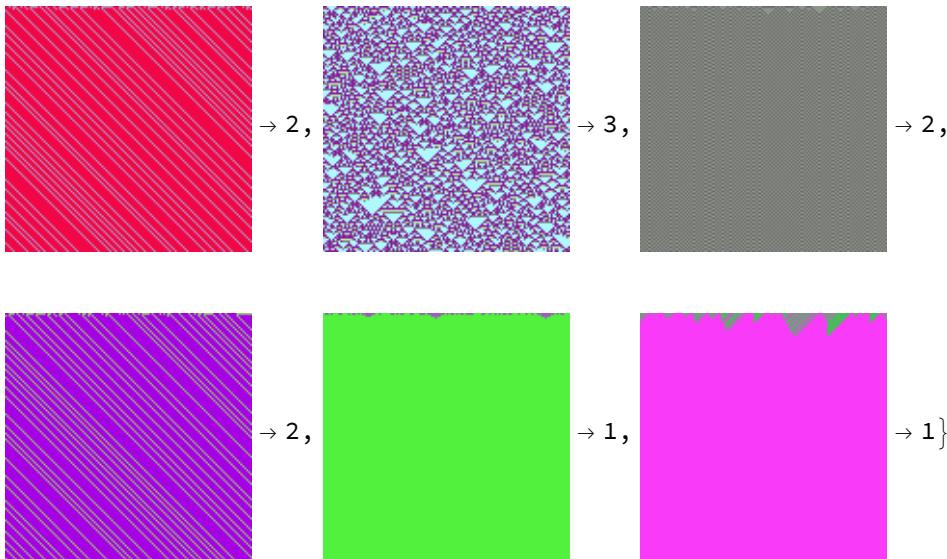
```
In[10]:= RandomSample[fullTrainingBigC13, 20]
```





In[®]:= **RandomSample[fullTrainingBigC13, 20]**





```
In[①]:= dir = SetDirectory[NotebookDirectory[]]
Out[①]= /Users/thorsilver/Downloads/Wolfram notebooks
```

```
In[②]:= netECA12 = Import["netECA12-r12.wlnet"]
```

```
Out[②]= NetChain[ Input
conv1 ConvolutionLayer
bat1 BatchNormalizationLayer
ramp1 Ramp
conv3 ConvolutionLayer
bat2 BatchNormalizationLayer
ramp2 Ramp
pooling PoolingLayer
flatten FlattenLayer
linear LinearLayer
drop2 DropoutLayer
linear2 LinearLayer
softmax SoftmaxLayer
Output
image
array (size: 3 × 120 × 200)
array (size: 24 × 118 × 198)
array (size: 24 × 118 × 198)
array (size: 24 × 118 × 198)
array (size: 24 × 116 × 196)
array (size: 24 × 116 × 196)
array (size: 24 × 116 × 196)
array (size: 24 × 1 × 5)
vector (size: 120)
vector (size: 512)
vector (size: 512)
vector (size: 4)
vector (size: 4)
class]
```

```
In[③]:= netECA13 = NetTrain[netECA13, fullTrainingBigC13,
  MaxTrainingRounds → 20, BatchSize → 256 * 4, TargetDevice → "CPU",
  TrainingProgressCheckpointing → {"Directory", dir}]
```

```
Out[③]= NetChain[ Input port: image
Output port: class
Number of layers: 12]
```

```
In[④]:= netECA13 = Import["netECA13-r20.wlnet"]
```

```
Out[④]= NetChain[ Input port: image
Output port: class
Number of layers: 12]
```

```
In[®]:= netECA13 = NetTrain[netECA13, fullTrainingBigC13,
  MaxTrainingRounds → 20, BatchSize → 256 * 4, TargetDevice → "CPU",
  TrainingProgressCheckpointing → {"Directory", dir}]
```

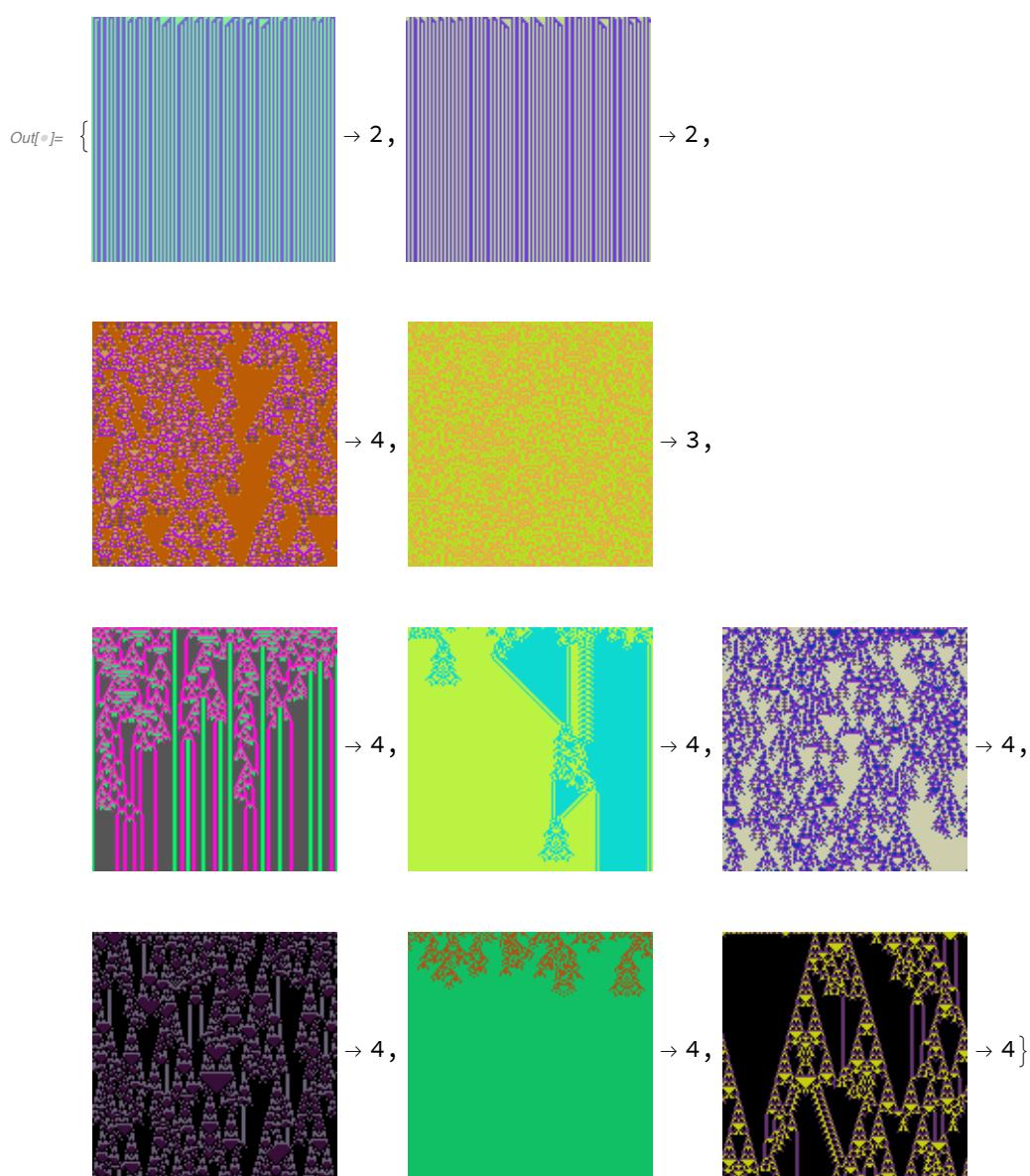
Out[®]= NetChain[ Input port: image
Output port: class
Number of layers: 12]

Generate test data for Network XIII

```
In[®]:= testDataECABigC = dataC[128, 128, 1024];
testData2TBigC = genData2r2C[128, 128, 1024];
testData3TBigC = data3T2C[128, 128, 1024];
testData4TBigC = data4TC[128, 128, 1024];
testData5TBigC = genData5TCC[128, 128, 1024];
fullTestSetBigC = Join[testDataECABigC,
  testData2TBigC, testData3TBigC, testData4TBigC, testData5TBigC];
Length[fullTestSetBigC]
```

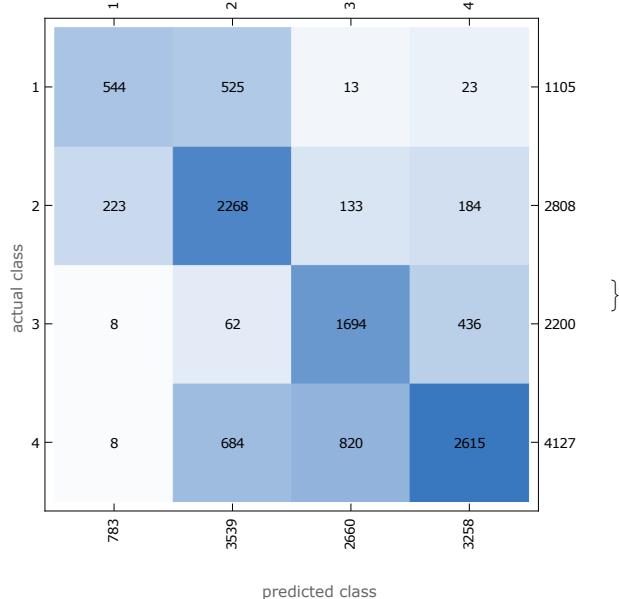
Out[®]= 10 240

In[8]:= RandomSample[fullTestSetBigC, 10]

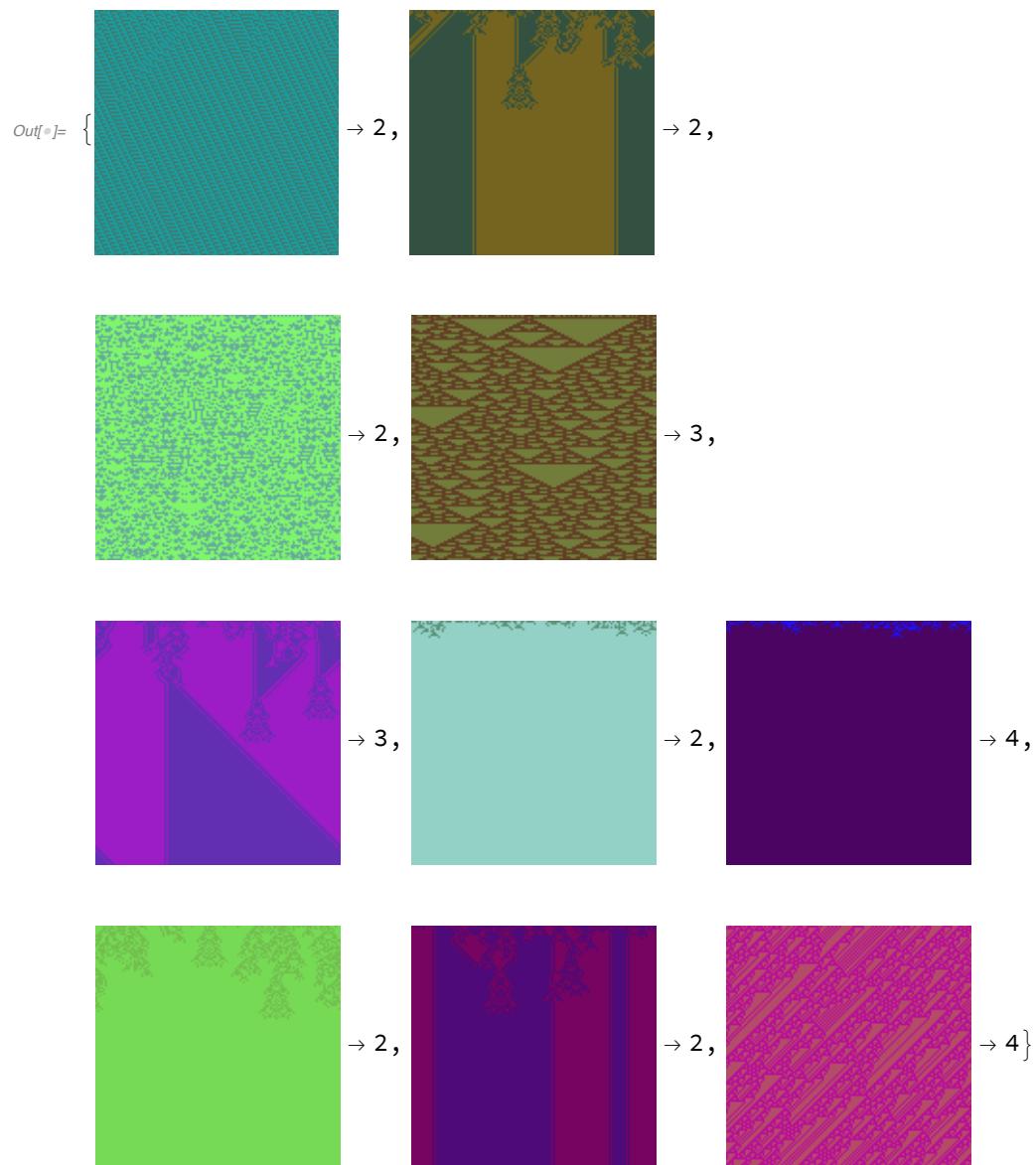


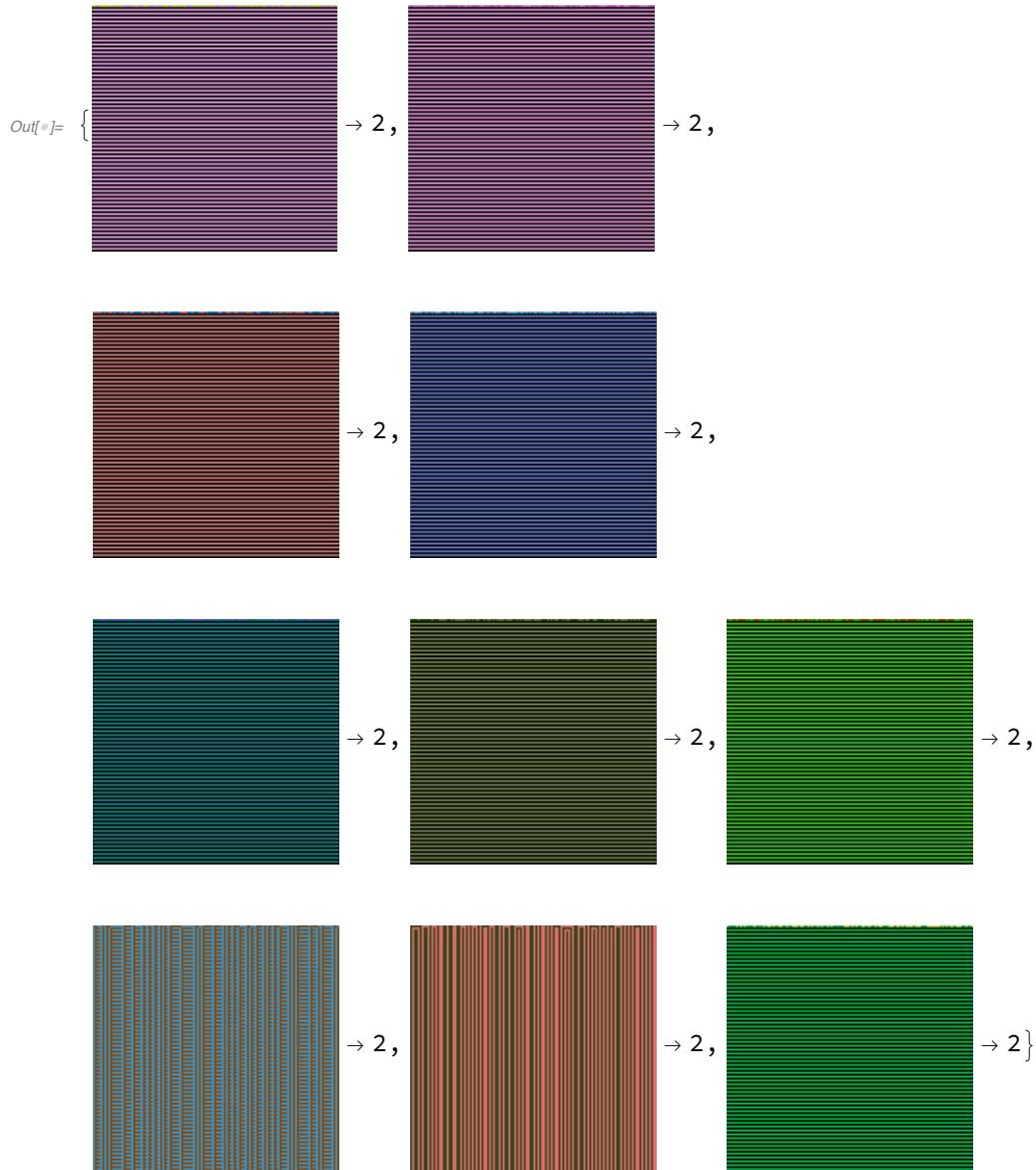
```
In[®]:= NetMeasurements[netECA13, fullTestSetBigC,
 {"Accuracy", "Precision", "ConfusionMatrixPlot"}]

Out[®]= {0.69541, <| 1 → 0.694764, 2 → 0.640859, 3 → 0.636842, 4 → 0.80264 |>, }
```



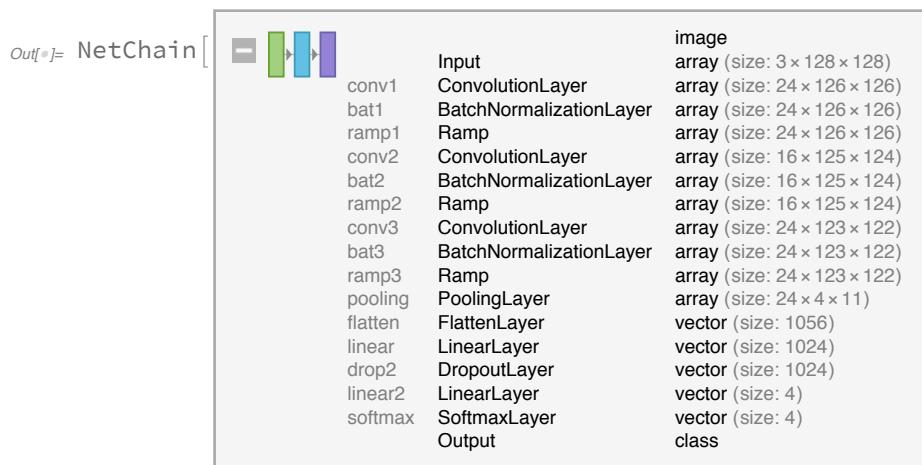
```
In[®]:= entropyImagesBigC = RandomSample[Keys[fullTestSetBigC], 500];
entropiesBigC = netECA13[entropyImagesBigC, "Entropy"];
highEntBigC = entropyImagesBigC[[Ordering[entropiesBigC, -10]]];
lowEntBigC = entropyImagesBigC[[Ordering[entropiesBigC, 10]]];
Thread[highEntBigC → netECA13[highEntBigC]]
Thread[lowEntBigC → netECA13[lowEntBigC]]
```





Network XIV - BatchNorm, 1024 linear, dropout

```
In[•]:= netECA14 = netEightCC512drop[128, 128]
```



```

netECA14 = NetTrain[netECA14, fullTrainingBigC13,
  MaxTrainingRounds → 20, BatchSize → 256 * 4, TargetDevice → "CPU",
  TrainingProgressCheckpointing → {"Directory", dir}]

In[]:= dir = SetDirectory[NotebookDirectory[]]
Out[]:= /Users/thorsilver/Downloads/Wolfram notebooks

In[]:= netECA14 = Import["netECA14-r20.wlnet"]

```

	Input	image
conv1	ConvolutionLayer	array (size: 3 × 128 × 128)
bat1	BatchNormalizationLayer	array (size: 24 × 126 × 126)
ramp1	Ramp	array (size: 24 × 126 × 126)
conv2	ConvolutionLayer	array (size: 24 × 125 × 124)
bat2	BatchNormalizationLayer	array (size: 16 × 125 × 124)
ramp2	Ramp	array (size: 16 × 125 × 124)
conv3	ConvolutionLayer	array (size: 24 × 123 × 122)
bat3	BatchNormalizationLayer	array (size: 24 × 123 × 122)
ramp3	Ramp	array (size: 24 × 123 × 122)
pooling	PoolingLayer	array (size: 24 × 4 × 11)
flatten	FlattenLayer	vector (size: 1056)
linear	LinearLayer	vector (size: 1024)
drop2	DropoutLayer	vector (size: 1024)
linear2	LinearLayer	vector (size: 4)
softmax	SoftmaxLayer	vector (size: 4)
Output		class

Generating test data for Network XIV

```

In[]:= testDataECABigC = dataC[128, 128, 1024];
testData2TBigC = genData2r2C[128, 128, 1024];
testData3TBigC = data3T2C[128, 128, 1024];
testData4TBigC = data4TC[128, 128, 1024];
testData5TBigC = genData5TCC[128, 128, 1024];
fullTestSetBigC = Join[testDataECABigC,
  testData2TBigC, testData3TBigC, testData4TBigC, testData5TBigC];
Length[fullTestSetBigC]

Out[]:= 10 240

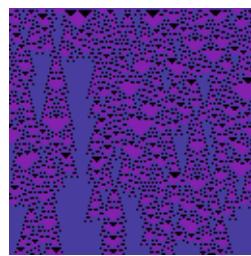
```

```
In[®]:= RandomSample[fullTestSetBigC, 10]
```

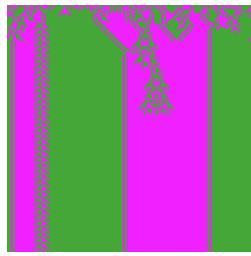
Out[®]= {



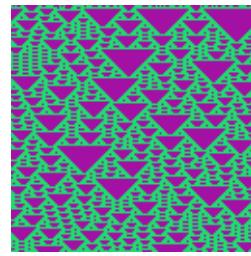
→ 4,



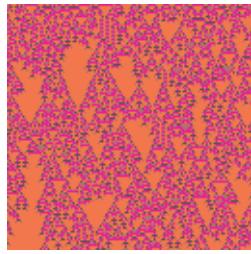
→ 4,



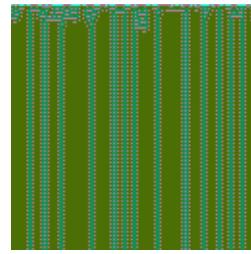
→ 4,



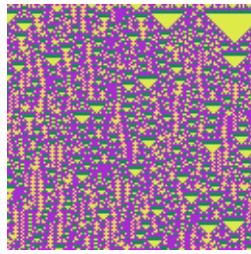
→ 3,



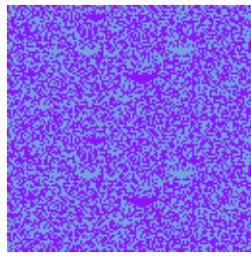
→ 4,



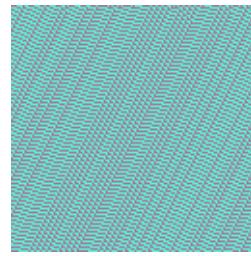
→ 2,



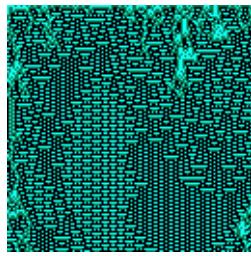
→ 3,



→ 3,



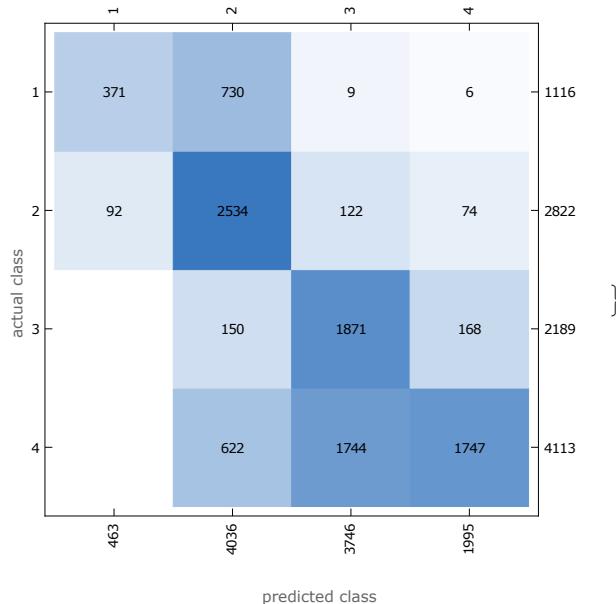
→ 2,



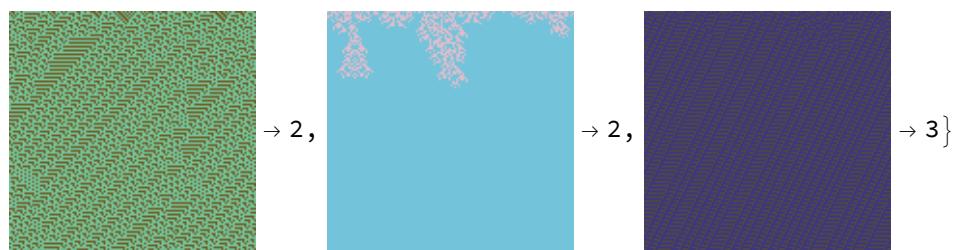
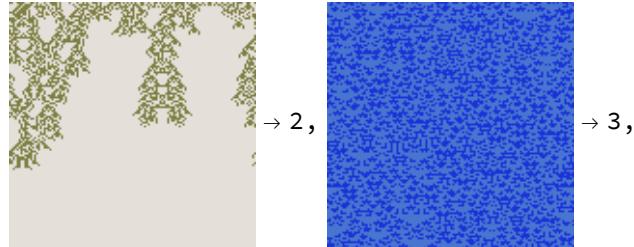
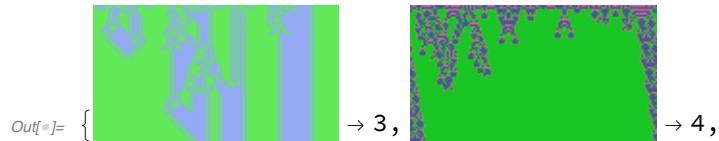
→ 4}

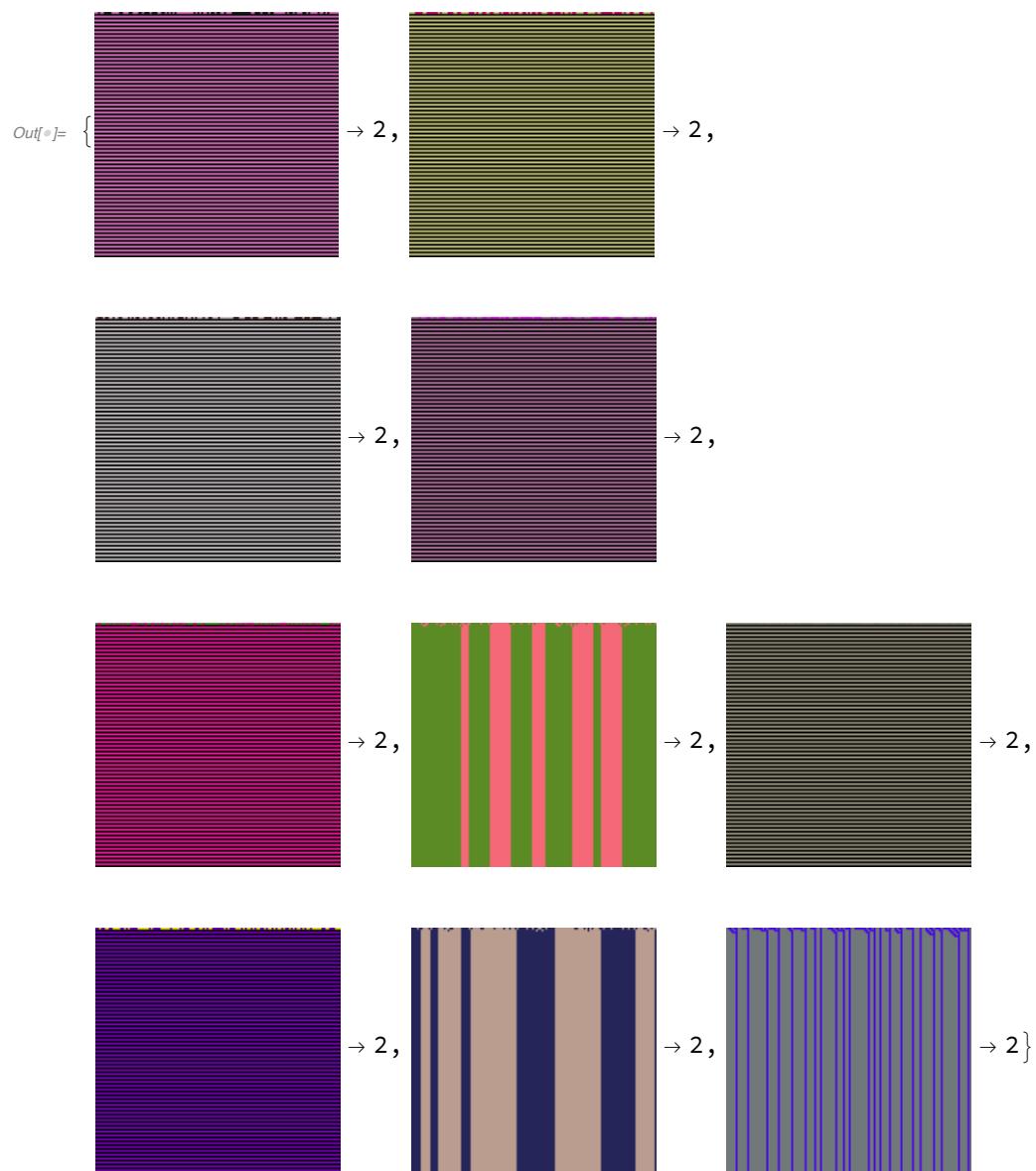
```
In[®]:= NetMeasurements[netECA14, fullTestSetBigC,
 {"Accuracy", "Precision", "ConfusionMatrixPlot"}]

Out[®]= {0.637012, <| 1 → 0.801296, 2 → 0.627849, 3 → 0.499466, 4 → 0.875689 |>, }
```



```
In[®]:= entropyImagesBigC = RandomSample[Keys[fullTestSetBigC], 500];
entropiesBigC = netECA14[entropyImagesBigC, "Entropy"];
highEntBigC = entropyImagesBigC[[Ordering[entropiesBigC, -10]]];
lowEntBigC = entropyImagesBigC[[Ordering[entropiesBigC, 10]]];
Thread[highEntBigC → netECA14[highEntBigC]]
Thread[lowEntBigC → netECA14[lowEntBigC]]
```





Network XV - Transfer learning with pre-trained image recognition net (VGG-16)

```
In[8]:= netECA15 = NetModel["VGG-16 Trained on ImageNet Competition Data"]
```



```
In[9]:= subNet = NetTake[netECA15, {"conv1_1", "flatten_0"}]
```



```
In[10]:= joinedNet = NetJoin[subNet,
  NetChain@<|"linear_new" → LinearLayer[1024], "linear_out" → LinearLayer[4],
  "prob" → SoftmaxLayer[]|>, "Output" → NetDecoder[{"Class", Range[1, 4]}]]
```



```
In[®]:= netECA15final =
NetPrepend[joinedNet, {"augment" → ImageAugmentationLayer[{224, 224}]], "Input" → NetExtract[joinedNet, "Input"]]

Out[®]= NetChain[]
```

In[®]:= dataECA15 = dataC[224, 224, 8192];

In[®]:= dataTotalistic2BigC15 = genData2r2C[224, 224, 1024];

In[®]:= dataTotalistic3BigC15 = data3T2C[224, 224, 512];

In[®]:= dataTotalistic4BigC15 = data4TC[224, 224, 512];

In[®]:= dataTotalistic5BigC15 = genData5TCC[224, 224, 1024];

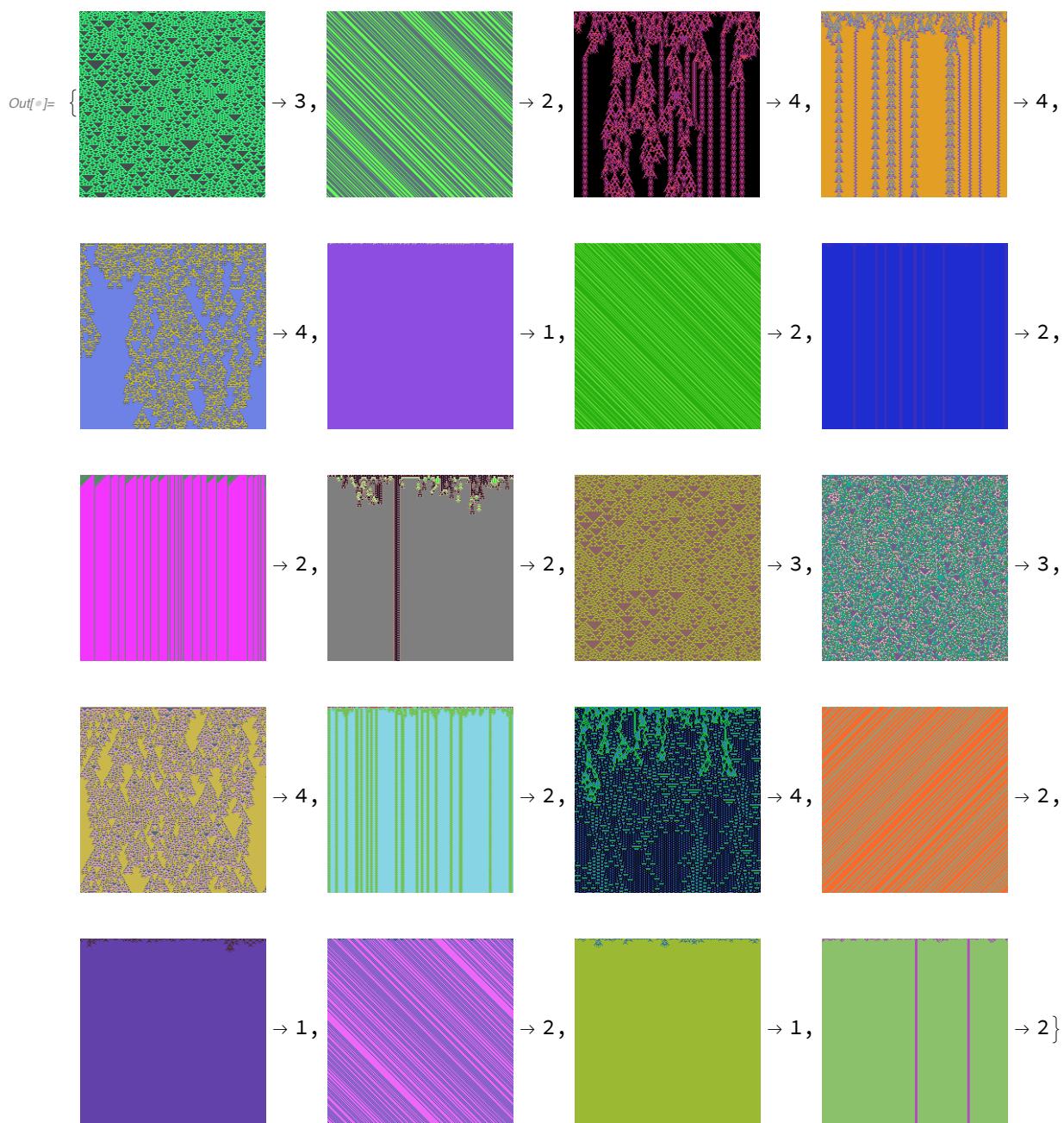
In[®]:= fullTrainingBigC15 = Join[dataECA15, dataTotalistic2BigC15,

dataTotalistic3BigC15, dataTotalistic4BigC15, dataTotalistic5BigC15];

Length[fullTrainingBigC15]

Out[®]= 16384

In[8]:= RandomSample[fullTrainingBigC15, 20]



In[9]:= netECA15final = NetTrain[netECA15final, fullTrainingBigC15,
 MaxTrainingRounds → 5, BatchSize → 256 * 4, TargetDevice → "CPU",
 TrainingProgressCheckpointing → {"Directory", dir},
 LearningRateMultipliers → {"linear_new" → 1, "linear_out" → 1, _ → 0}]

Network XVI - Three convolutions, dropout on linear only, BatchNorm

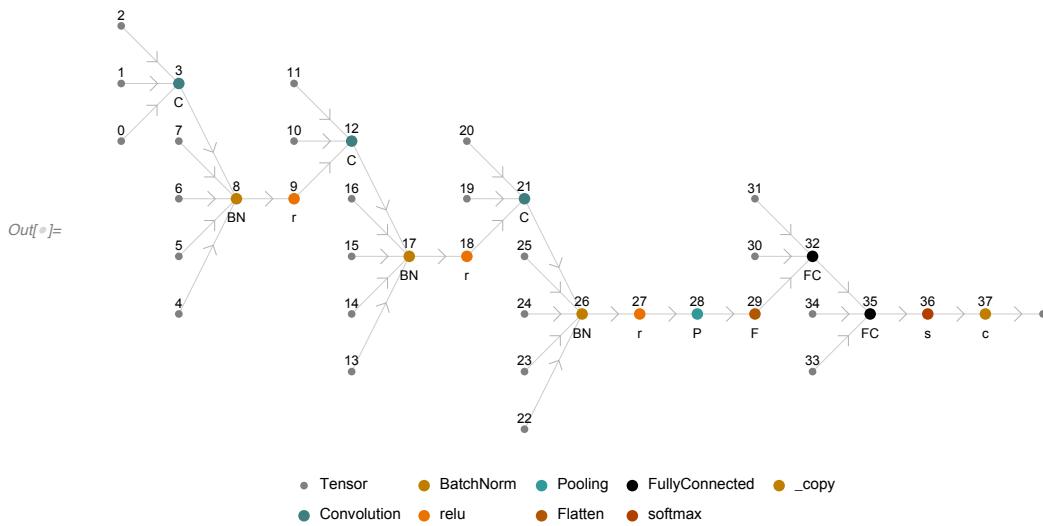
In[10]:= netECA16 = netNineCC512drop[128, 128]

Out[10]= NetChain[

	Input port:	image
	Output port:	class
	Number of layers:	15

]

```
In[⑩]:= NetInformation[netECA16, "MXNetNodeGraphPlot"]
```



```
In[⑪]:= NetInformation[netECA16, "SummaryGraphic"]
```



```
In[⑫]:= dataECA16 = dataC[128, 128, 8192];
```

```
In[⑬]:= dataTotalistic2BigC16 = genData2r2C[128, 128, 1024];
```

```
In[⑭]:= dataTotalistic3BigC16 = data3T2C[128, 128, 1024];
```

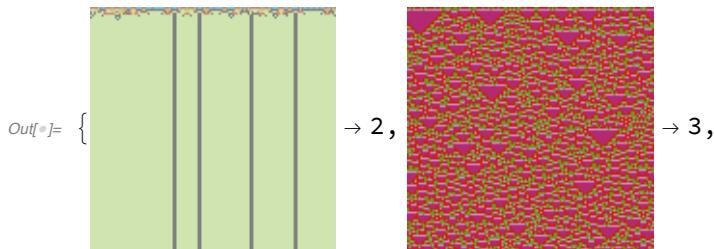
```
In[⑮]:= dataTotalistic4BigC16 = data4TC[128, 128, 1024];
```

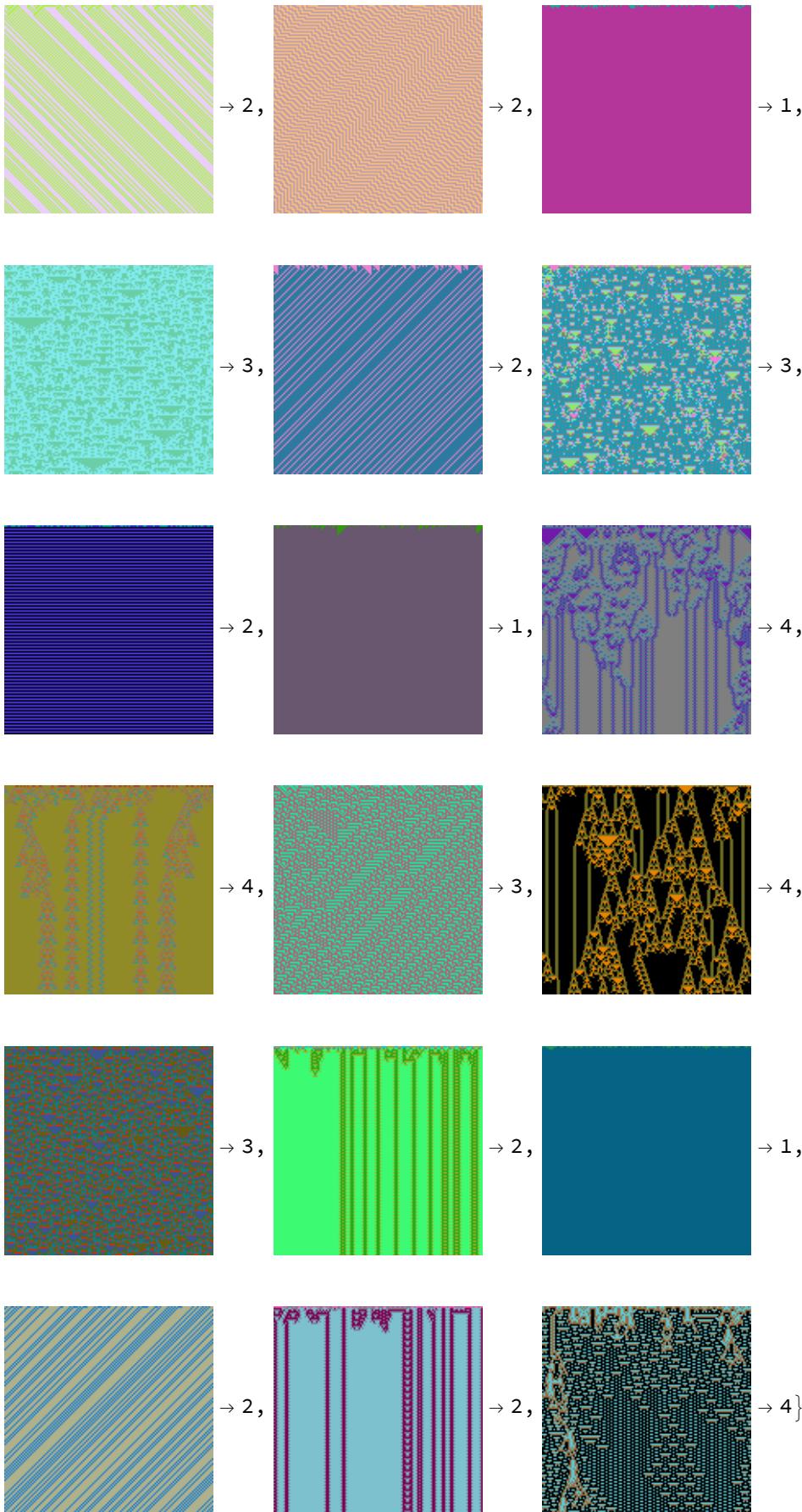
```
In[⑯]:= dataTotalistic5BigC16 = genData5TCC[128, 128, 4096];
```

```
In[⑰]:= fullTrainingBigC16 = Join[dataECA16, dataTotalistic2BigC16,
  dataTotalistic3BigC16, dataTotalistic4BigC16, dataTotalistic5BigC16];
Length[fullTrainingBigC16]
```

Out[⑰]= 26624

```
In[⑱]:= RandomSample[fullTrainingBigC16, 20]
```





```
In[®]:= dir = SetDirectory[NotebookDirectory[]]
Out[®]= /home/esilverman/Documents

In[®]:= netECA16 = NetTrain[netECA16, fullTrainingBigC16,
  MaxTrainingRounds → 200, BatchSize → 256, TargetDevice → "GPU",
  TrainingProgressCheckpointing → {"Directory", dir}]

Out[®]= NetChain[ Input port: image class  
Output port: image class  
Number of layers: 15]

netECA16 = Import["netECA16-r20.wlnet"]

netECA16 = NetTrain[netECA16, fullTrainingBigC16,
  MaxTrainingRounds → 20, BatchSize → 256 * 4, TargetDevice → "CPU",
  TrainingProgressCheckpointing → {"Directory", dir}]
```

Generate test data for Network XVI

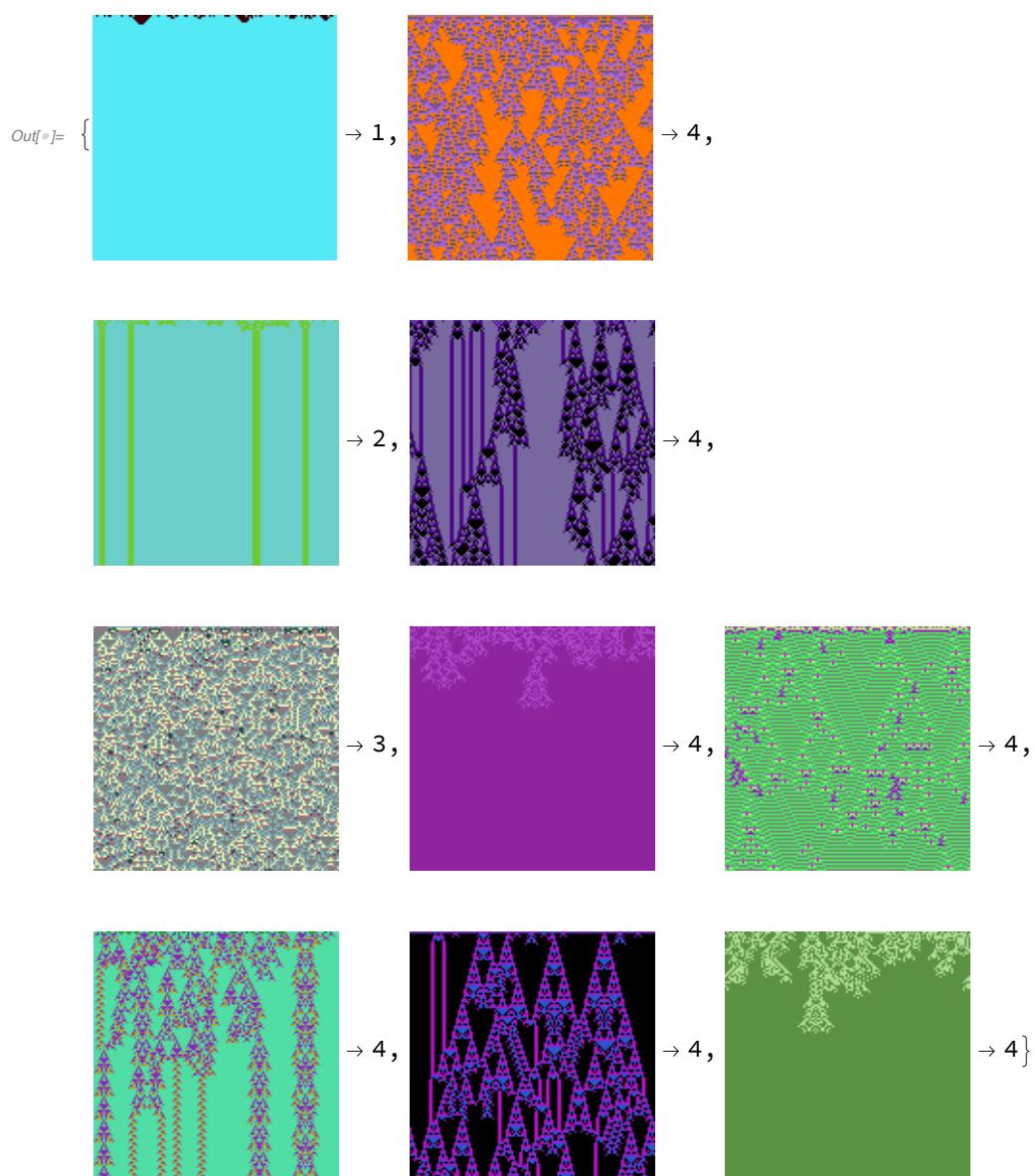
```
In[®]:= dir = SetDirectory[NotebookDirectory[]]
Out[®]= /Users/thorsilver/Downloads/Wolfram notebooks

In[®]:= netECA16 = Import["netECA16-r20.wlnet"]
Out[®]= NetChain[ Input port: image class  
Output port: image class  
Number of layers: 15]

In[®]:= testDataECABigC = dataC[128, 128, 1024];
testData2TBigC = genData2r2C[128, 128, 1024];
testData3TBigC = data3T2C[128, 128, 1024];
testData4TBigC = data4TC[128, 128, 1024];
testData5TBigC = genData5TCC[128, 128, 1024];
fullTestSetBigC = Join[testDataECABigC,
  testData2TBigC, testData3TBigC, testData4TBigC, testData5TBigC];
Length[fullTestSetBigC]

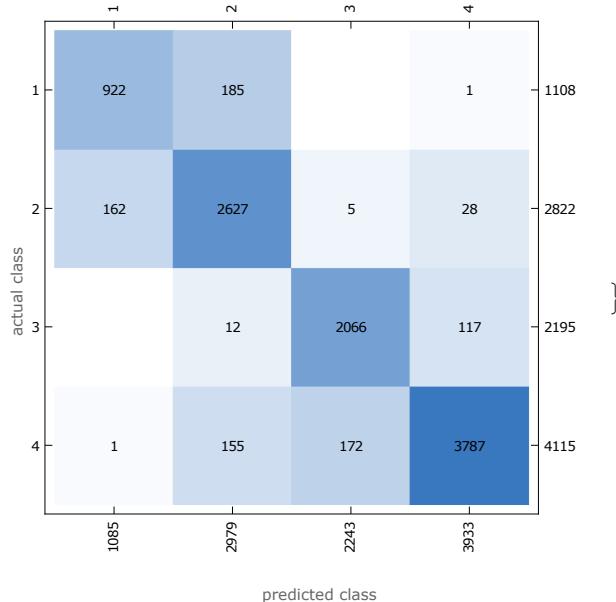
Out[®]= 10 240
```

In[8]:= `RandomSample[fullTestSetBigC, 10]`

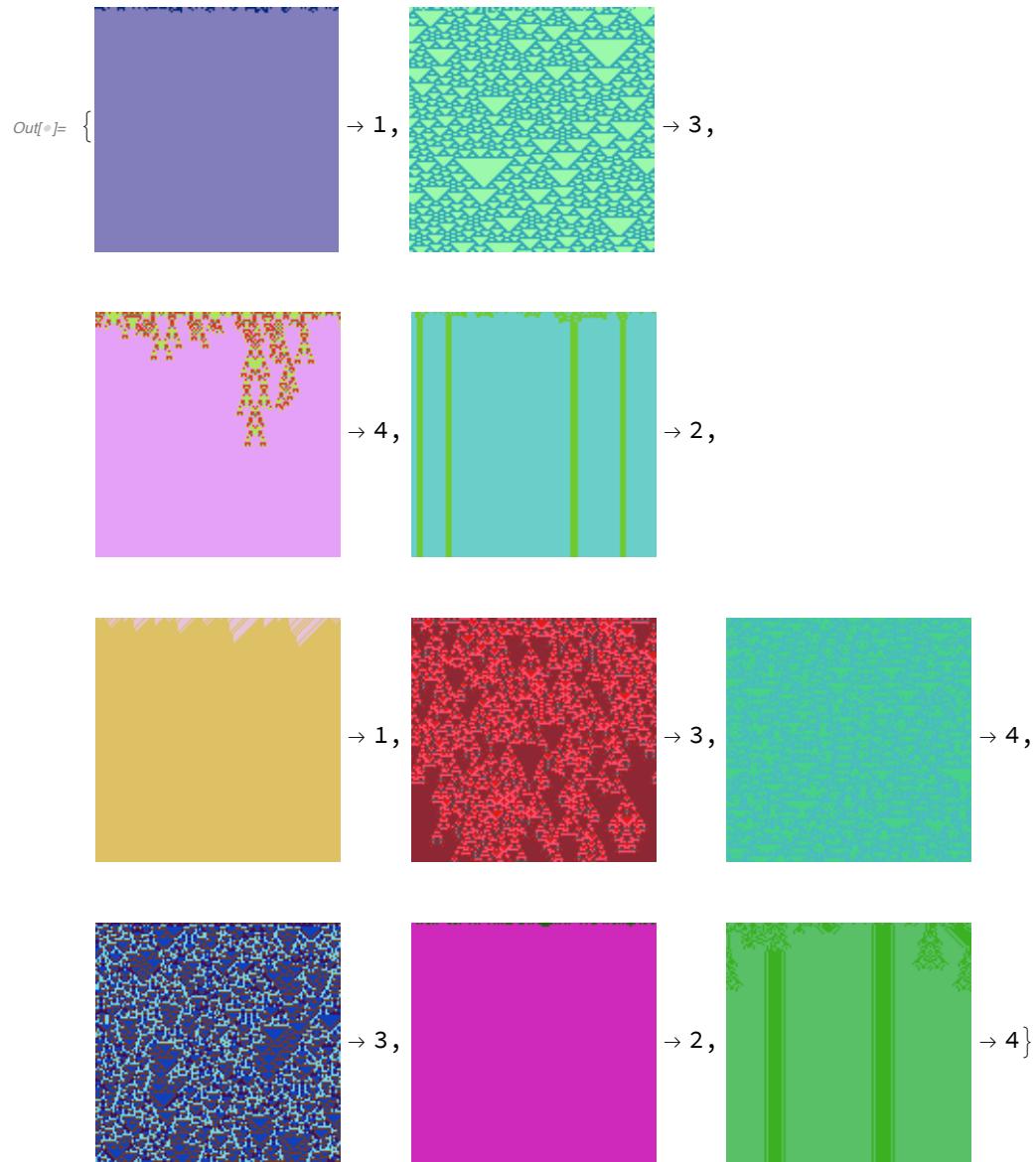


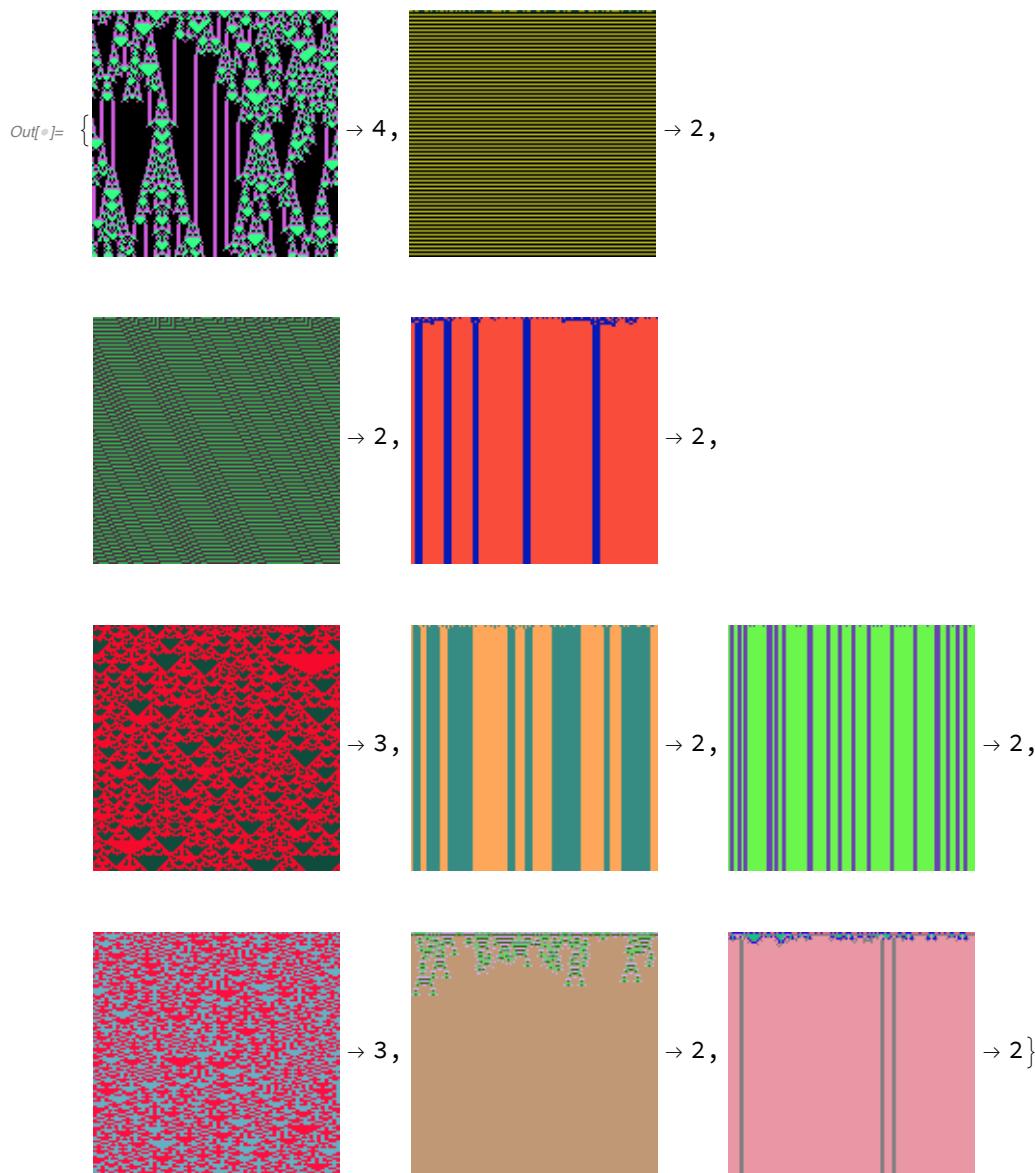
```
In[®]:= NetMeasurements[netECA16, fullTestSetBigC,
 {"Accuracy", "Precision", "ConfusionMatrixPlot"}]

Out[®]= {0.918164, <| 1 → 0.84977, 2 → 0.88184, 3 → 0.921088, 4 → 0.962878 |>, }
```



```
In[®]:= entropyImagesBigC = RandomSample[Keys[fullTestSetBigC], 500];
entropiesBigC = netECA16[entropyImagesBigC, "Entropy"];
highEntBigC = entropyImagesBigC[[Ordering[entropiesBigC, -10]]];
lowEntBigC = entropyImagesBigC[[Ordering[entropiesBigC, 10]]];
Thread[highEntBigC → netECA16[highEntBigC]]
Thread[lowEntBigC → netECA16[lowEntBigC]]
```





Testing Network XVI on unseen CA rule spaces

2-colour non-totalistic, range 2

```
In[•]:= test4Data2kr2C16 = datak2r2C[128, 128, 8];
Thread[
  test4Data2kr2C16 → netECA16[Keys@test4Data2kr2C16, {"TopProbabilities", 2}]]
```

Out[•]= {

→ 142 978 078 → {4 → 0.0000385332, 3 → 0.999961},

$$\left(\begin{array}{c} \text{[A 2x2 grid of small black dots on a white background]} \\ \rightarrow 2\ 651\ 048\ 833 \end{array} \right) \rightarrow \{4 \rightarrow 8.69455 \times 10^{-12}, 2 \rightarrow 1.\},$$

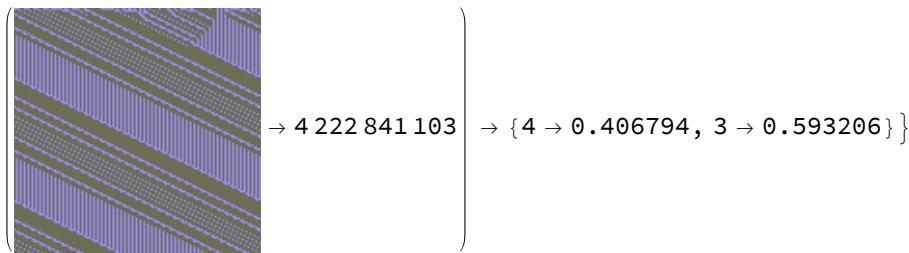
$$\left(\begin{array}{c} \text{[A 2x2 grid of small black dots on a white background]} \\ \rightarrow 2\ 132\ 867\ 963 \end{array} \right) \rightarrow \{4 \rightarrow 2.86202 \times 10^{-17}, 2 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 2x2 grid of small black dots on a white background]} \\ \rightarrow 3\ 644\ 758\ 968 \end{array} \right) \rightarrow \{4 \rightarrow 6.11899 \times 10^{-7}, 3 \rightarrow 0.999999\},$$

$$\left(\begin{array}{c} \text{[A 2x2 grid of small black dots on a white background]} \\ \rightarrow 1\ 762\ 420\ 096 \end{array} \right) \rightarrow \{1 \rightarrow 2.34707 \times 10^{-9}, 2 \rightarrow 1.\},$$

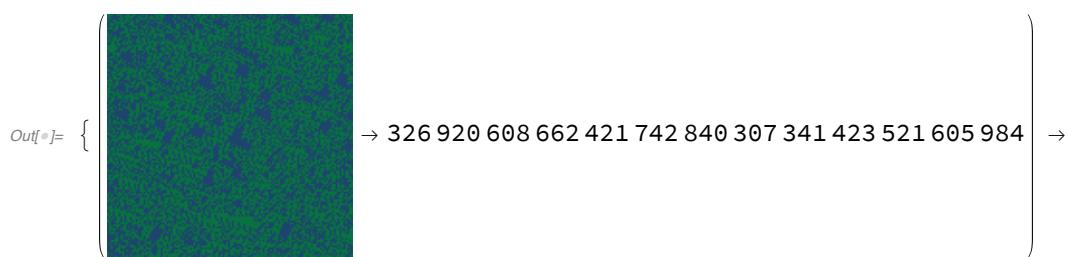
$$\left(\begin{array}{c} \text{[A 2x2 grid of small black dots on a white background]} \\ \rightarrow 1\ 983\ 429\ 391 \end{array} \right) \rightarrow \{4 \rightarrow 0.0547227, 3 \rightarrow 0.945277\},$$

$$\left(\begin{array}{c} \text{[A 2x2 grid of small black dots on a white background]} \\ \rightarrow 3\ 013\ 553\ 323 \end{array} \right) \rightarrow \{3 \rightarrow 0.0109364, 2 \rightarrow 0.989064\},$$

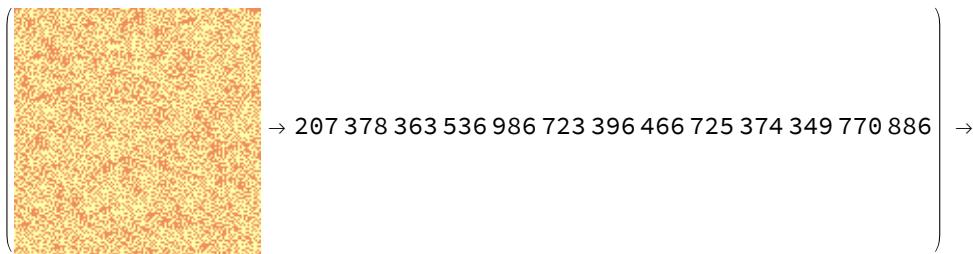


2-colour non-totalistic, range 3

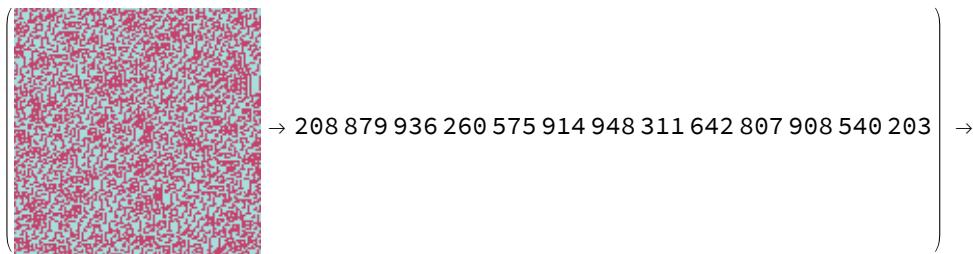
```
In[]:= test4Data2kr3C16 = datak2r3NT[128, 128, 8];
Thread[
test4Data2kr3C16 → netECA16[Keys@test4Data2kr3C16, {"TopProbabilities", 2}]]
```



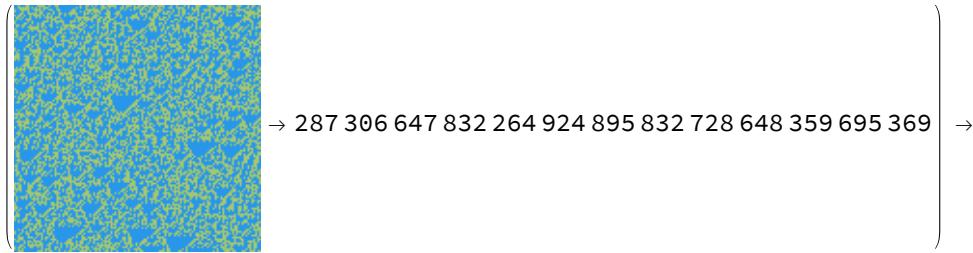
$\{ 4 \rightarrow 0.250823, 3 \rightarrow 0.749175 \},$

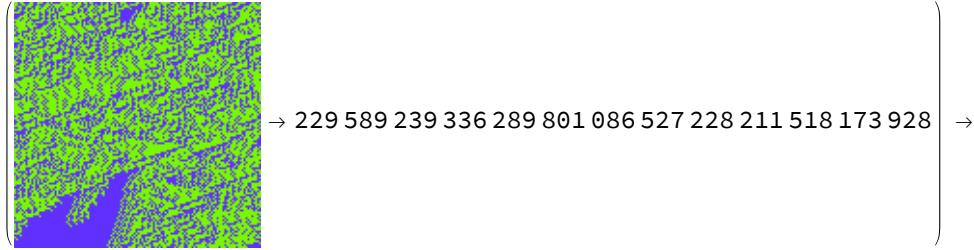
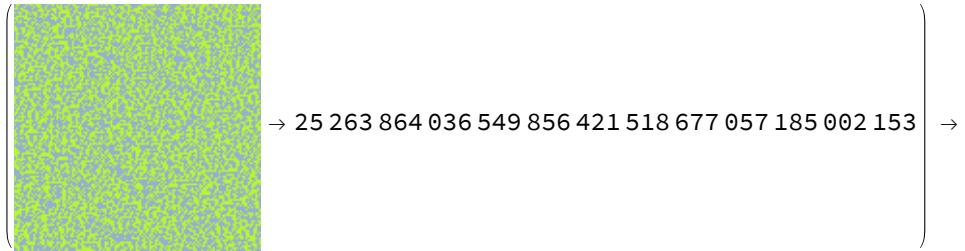
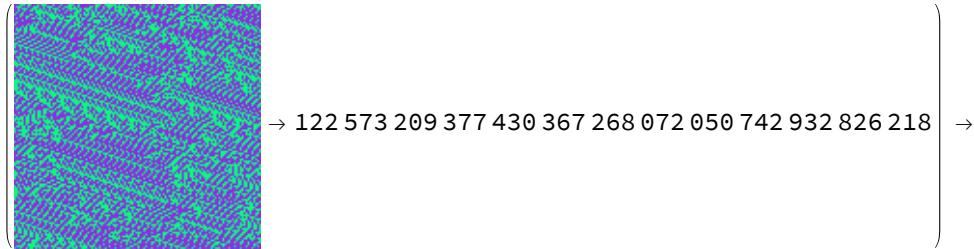
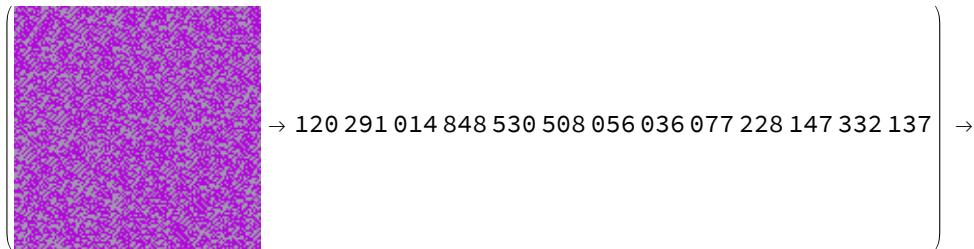


$\{ 4 \rightarrow 3.99297 \times 10^{-14}, 3 \rightarrow 1. \},$



$\{ 4 \rightarrow 1.58015 \times 10^{-11}, 3 \rightarrow 1. \},$



$\{4 \rightarrow 1.21845 \times 10^{-8}, 3 \rightarrow 1.\},$

 $\{3 \rightarrow 0.0173989, 4 \rightarrow 0.982601\},$

 $\{4 \rightarrow 2.486 \times 10^{-11}, 3 \rightarrow 1.\},$

 $\{4 \rightarrow 1.46881 \times 10^{-9}, 3 \rightarrow 1.\},$

 $\{4 \rightarrow 0.00683298, 3 \rightarrow 0.993167\}$

3-colour non-totalistic, range 1

```
In[6]:= test4Data3kr1C16 = datak3r1NT[128, 128, 8];
Thread[
test4Data3kr1C16 → netECA16[Keys@test4Data3kr1C16, {"TopProbabilities", 2}]]
```

Out[•]= $\left\{ \begin{array}{c} \text{(A 10x10 grid of black and white dots)} \\ \rightarrow 4\ 431\ 477\ 695\ 805 \end{array} \right\} \rightarrow \{ 4 \rightarrow 0.000746188, 3 \rightarrow 0.999254 \},$

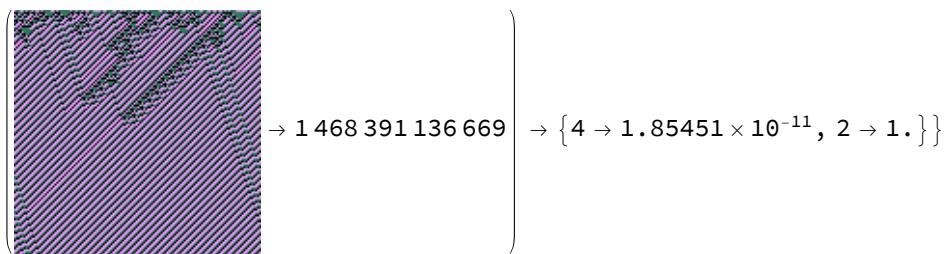
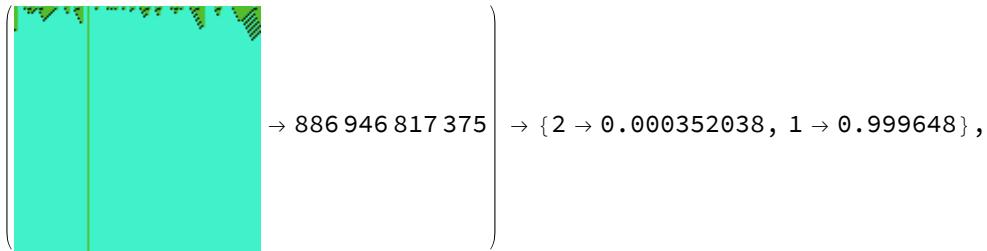
$\left\{ \begin{array}{c} \text{(A 10x10 grid of green and black diagonal stripes)} \\ \rightarrow 1\ 627\ 958\ 441\ 874 \end{array} \right\} \rightarrow \{ 4 \rightarrow 0.00025369, 3 \rightarrow 0.999746 \},$

$\left\{ \begin{array}{c} \text{(A 10x10 grid of red and blue diagonal stripes)} \\ \rightarrow 4\ 241\ 674\ 451\ 024 \end{array} \right\} \rightarrow \{ 3 \rightarrow 0.194892, 2 \rightarrow 0.805108 \},$

$\left\{ \begin{array}{c} \text{(A 10x10 grid of orange and teal dots)} \\ \rightarrow 4\ 177\ 916\ 755\ 057 \end{array} \right\} \rightarrow \{ 3 \rightarrow 9.07174 \times 10^{-18}, 4 \rightarrow 1. \},$

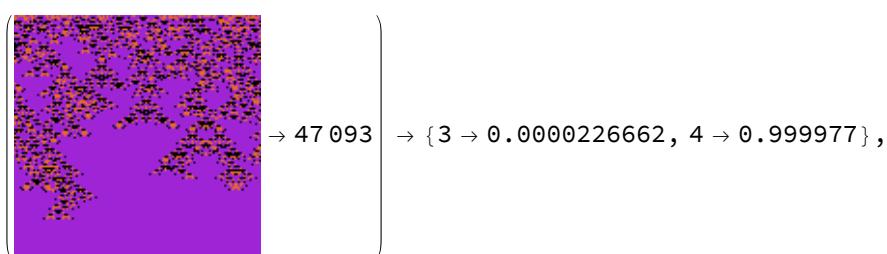
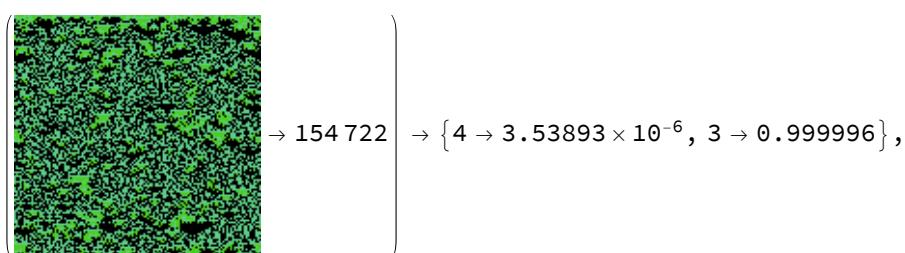
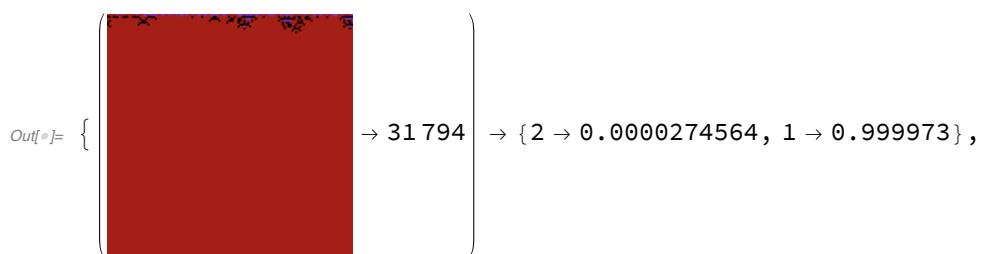
$\left\{ \begin{array}{c} \text{(A 10x10 grid of vertical red and green bars)} \\ \rightarrow 2\ 504\ 235\ 138\ 103 \end{array} \right\} \rightarrow \{ 4 \rightarrow 1.3375 \times 10^{-21}, 2 \rightarrow 1. \},$

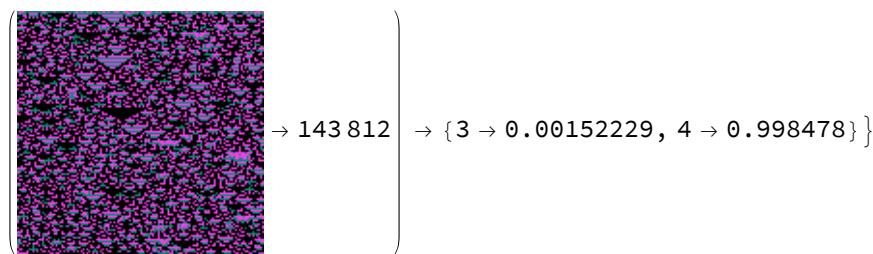
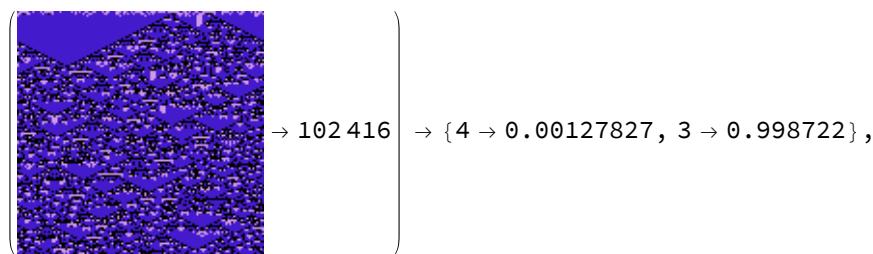
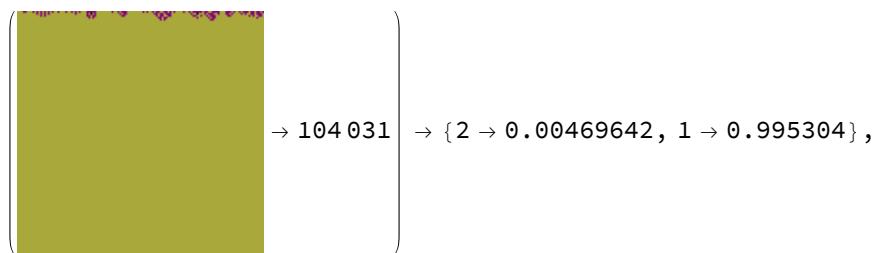
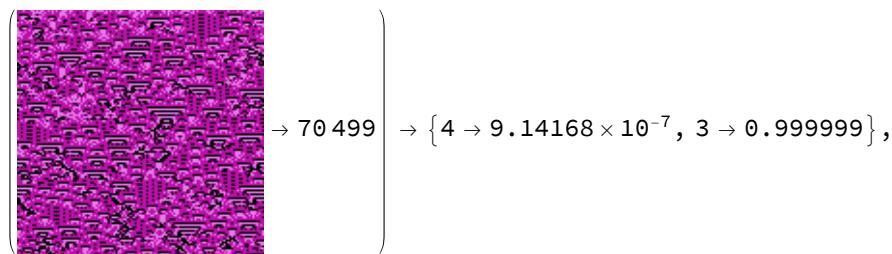
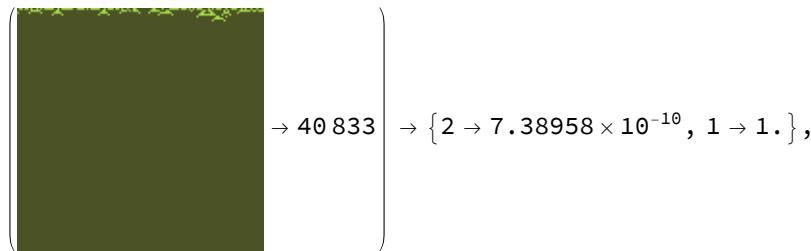
$\left\{ \begin{array}{c} \text{(A 10x10 grid of yellow and magenta dots)} \\ \rightarrow 2\ 281\ 646\ 033\ 785 \end{array} \right\} \rightarrow \{ 4 \rightarrow 0.164883, 3 \rightarrow 0.835117 \},$



3-colour totalistic, range 2

```
In[]:= test4Data3kr2C16 = datak3r2C[128, 128, 8];
Thread[
  test4Data3kr2C16 → netECA16[Keys@test4Data3kr2C16, {"TopProbabilities", 2}]]
```





3-colour totalistic, range 3

```
In[④]:= test4Data3kr3C16 = datak3r3C[128, 128, 8];
Thread[
test4Data3kr3C16 → netECA16[Keys@test4Data3kr3C16, {"TopProbabilities", 2}]]
```

$Out[8]= \left\{ \begin{array}{l} \text{A 2D grid of red and green pixels} \\ \rightarrow 9694493 \end{array} \right\} \rightarrow \{3 \rightarrow 0.480724, 4 \rightarrow 0.519276\},$

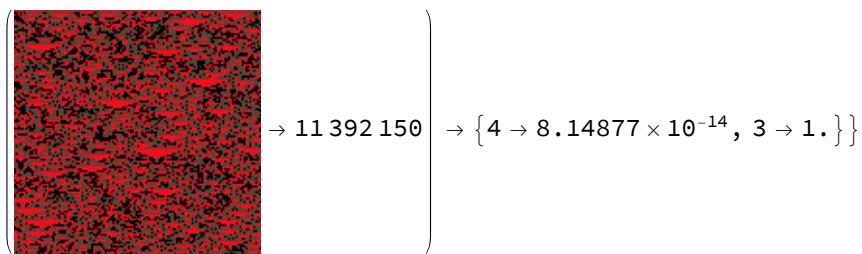
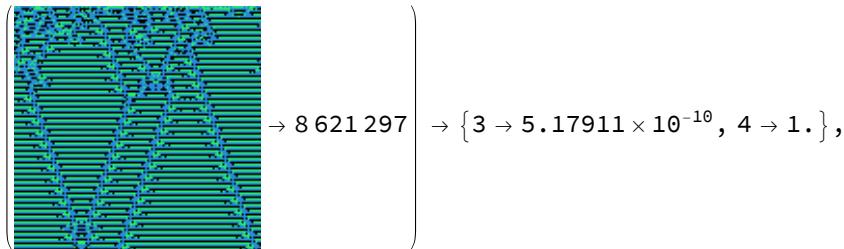
$\left\{ \begin{array}{l} \text{A 2D grid of black, pink, and purple pixels} \\ \rightarrow 1266350 \end{array} \right\} \rightarrow \{3 \rightarrow 2.07073 \times 10^{-17}, 4 \rightarrow 1.\},$

$\left\{ \begin{array}{l} \text{A 2D grid of green and black pixels} \\ \rightarrow 10922251 \end{array} \right\} \rightarrow \{4 \rightarrow 0.0000302967, 3 \rightarrow 0.99997\},$

$\left\{ \begin{array}{l} \text{A 2D grid of red, blue, and cyan pixels} \\ \rightarrow 10284081 \end{array} \right\} \rightarrow \{4 \rightarrow 0.0000121386, 3 \rightarrow 0.999988\},$

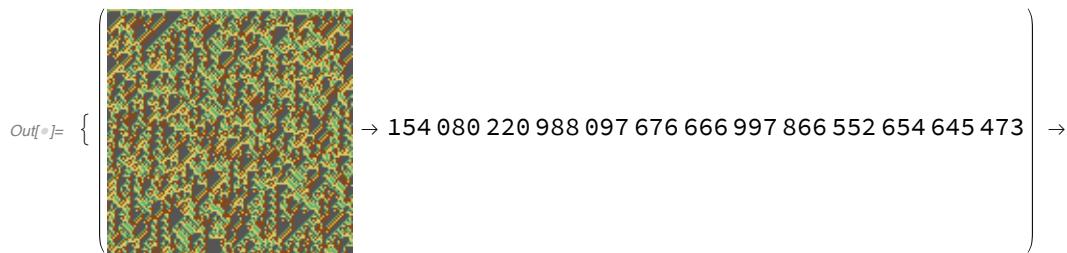
$\left\{ \begin{array}{l} \text{A uniform blue 2D grid} \\ \rightarrow 3664255 \end{array} \right\} \rightarrow \{1 \rightarrow 0.0137727, 2 \rightarrow 0.986227\},$

$\left\{ \begin{array}{l} \text{A 2D grid of green and purple pixels} \\ \rightarrow 10298881 \end{array} \right\} \rightarrow \{4 \rightarrow 0.000133186, 3 \rightarrow 0.999867\},$

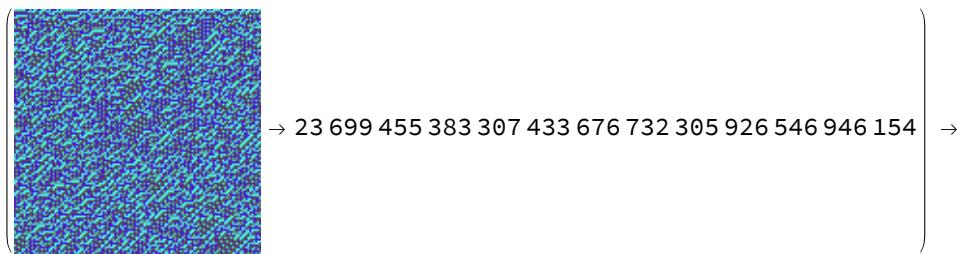


4-colour non-totalistic, range 1

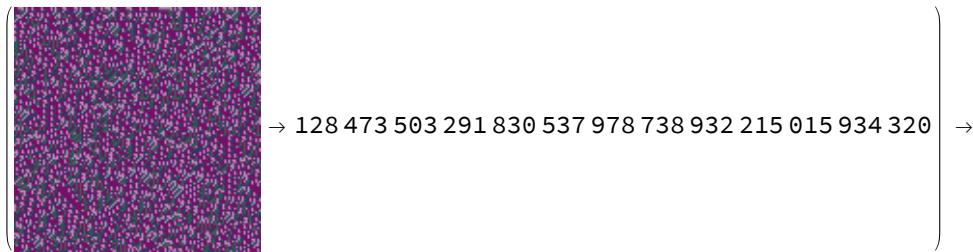
```
In[]:= test4Data4kr1C16 = datak4r1NT[128, 128, 8];
Thread[
  test4Data4kr1C16 → netECA16[Keys@test4Data4kr1C16, {"TopProbabilities", 2}]]
```



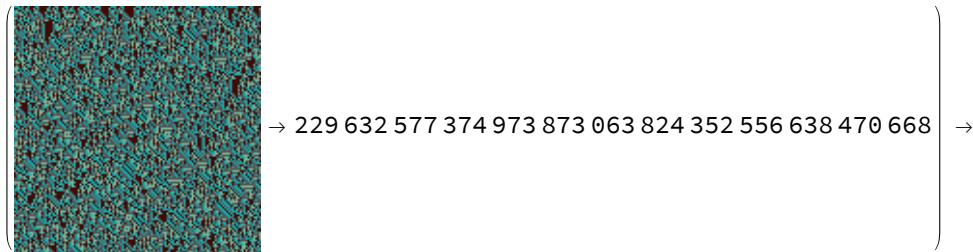
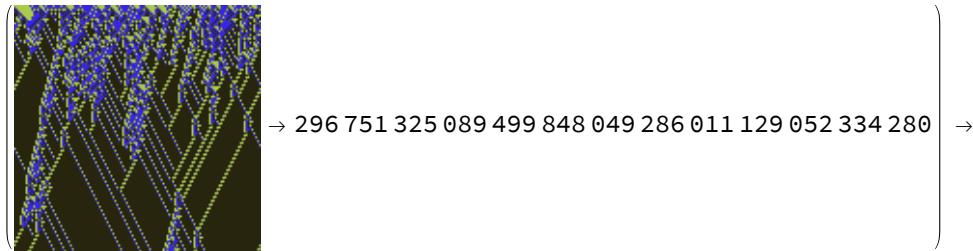
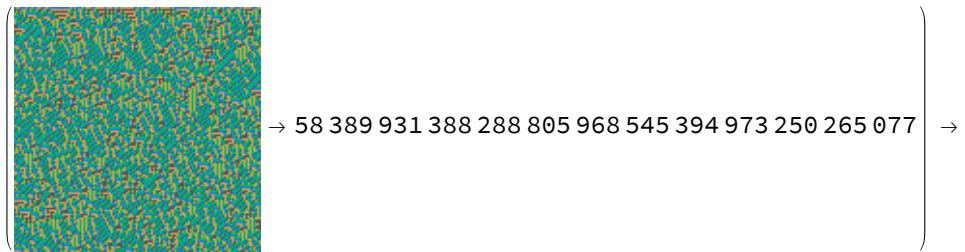
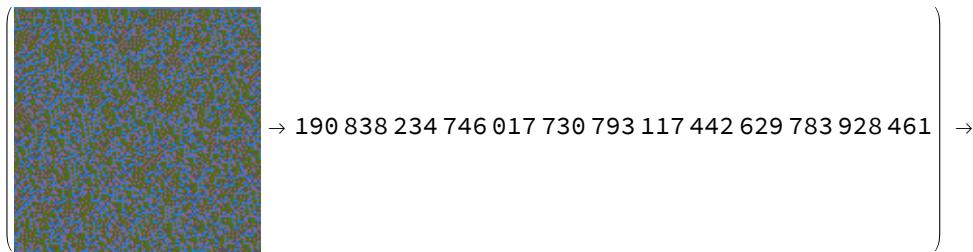
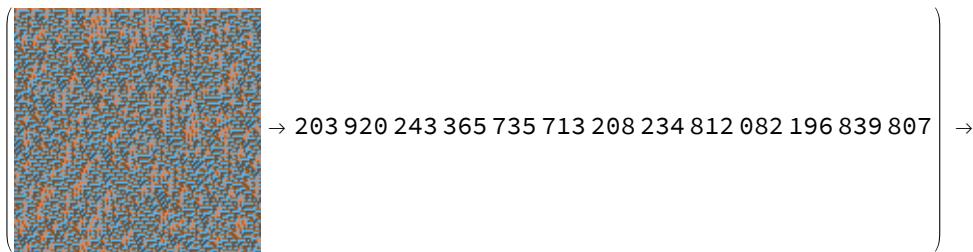
$\{3 \rightarrow 2.29402 \times 10^{-6}, 4 \rightarrow 0.999998\},$



$\{4 \rightarrow 9.18698 \times 10^{-10}, 3 \rightarrow 1.\},$

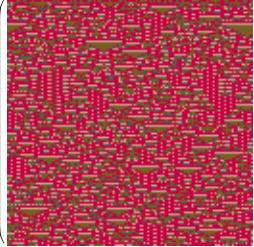


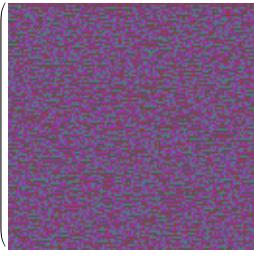
$\{4 \rightarrow 0.016884, 3 \rightarrow 0.983116\},$

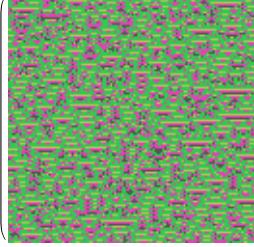

 $\{3 \rightarrow 3.66751 \times 10^{-6}, 4 \rightarrow 0.999996\},$

 $\{2 \rightarrow 0.03566663, 4 \rightarrow 0.964334\},$

 $\{4 \rightarrow 0.392533, 3 \rightarrow 0.607467\},$

 $\{3 \rightarrow 0.0000369307, 4 \rightarrow 0.999963\},$

 $\{4 \rightarrow 0.00577653, 3 \rightarrow 0.994223\}$

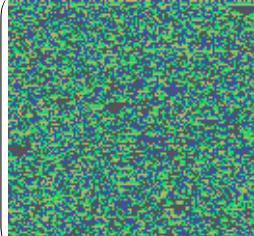
4-colour totalistic, range 2

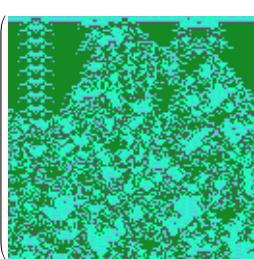
```
In[®]:= test4Data4kr2C16 = datak4r2C[128, 128, 8];
Thread[
  test4Data4kr2C16 → netECA16[Keys@test4Data4kr2C16, {"TopProbabilities", 2}]]
```

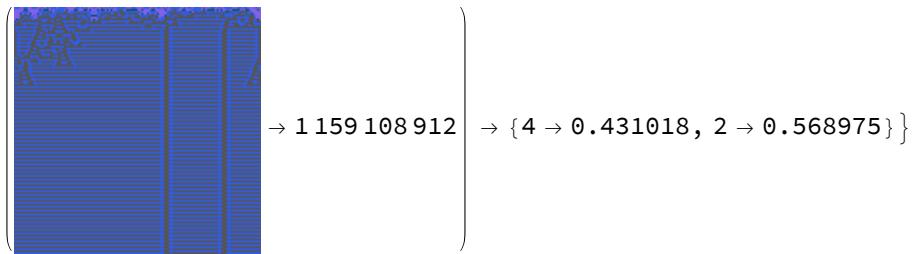
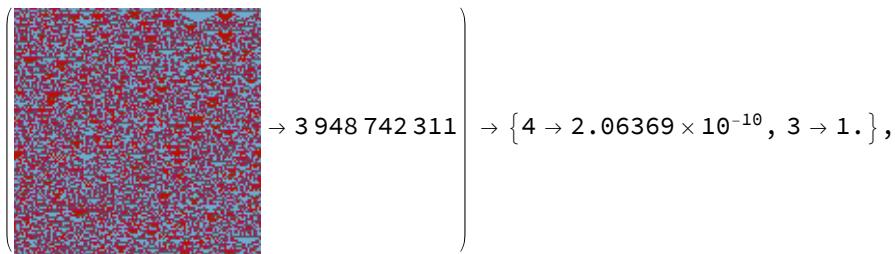
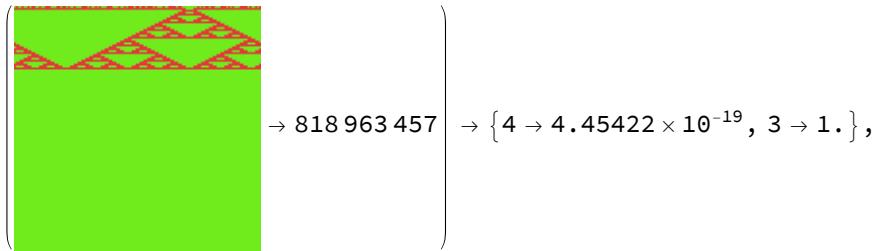
Out[®]= { → 25 517 204} → {4 → 1.29127×10^{-13} , 3 → 1.},

{ → 3 053 925 273} → {4 → 0.00215091, 3 → 0.997849},

{ → 2 735 868 989} → {4 → 0.000282149, 3 → 0.999718},

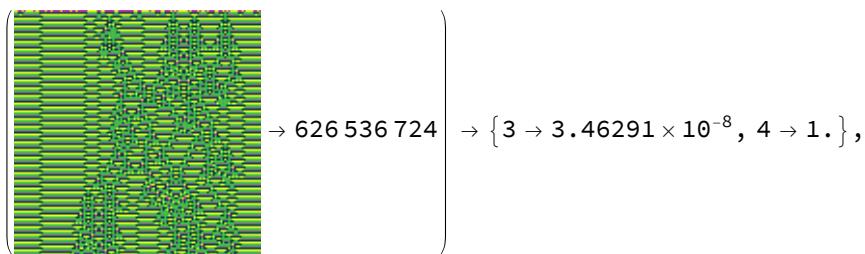
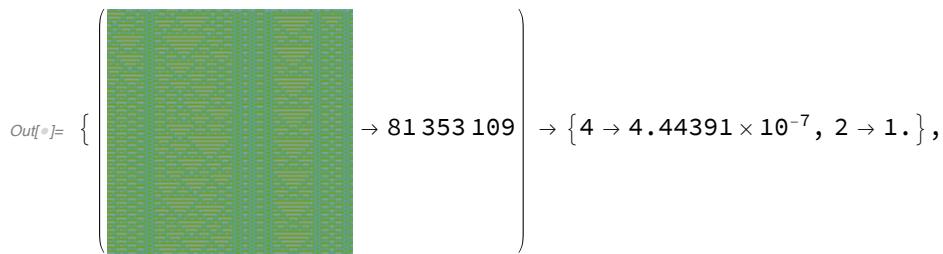
{ → 1 440 927 950} → {4 → 0.0889018, 3 → 0.911098},

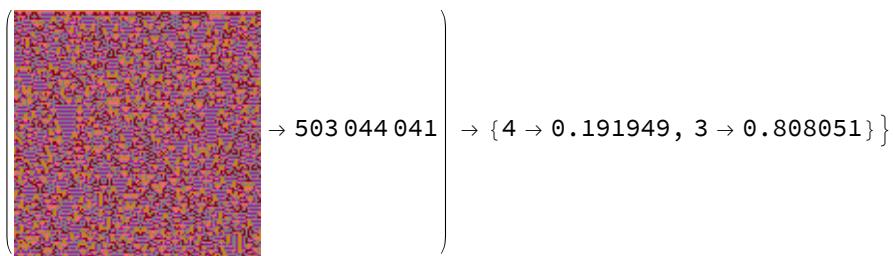
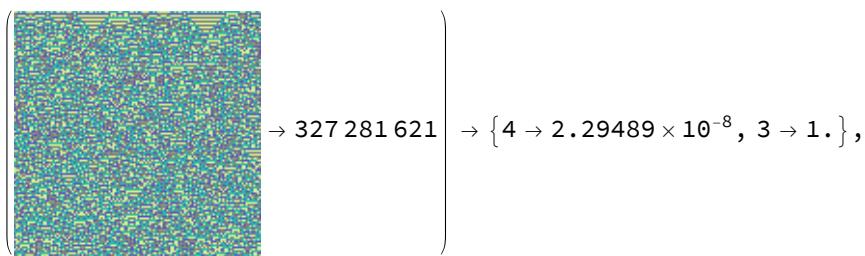
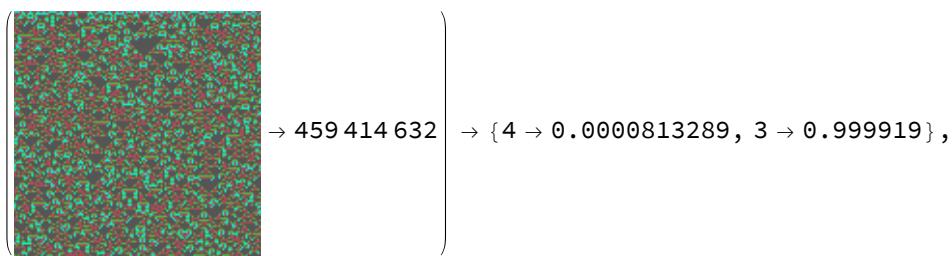
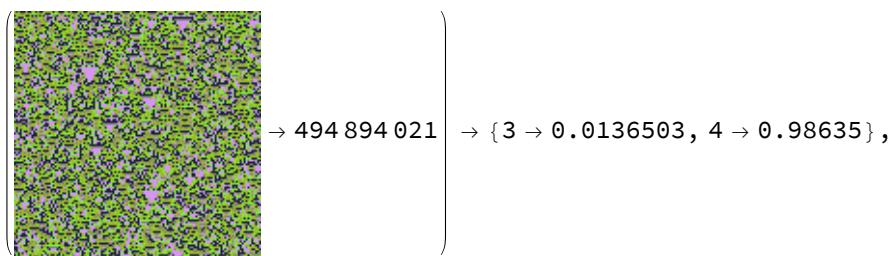
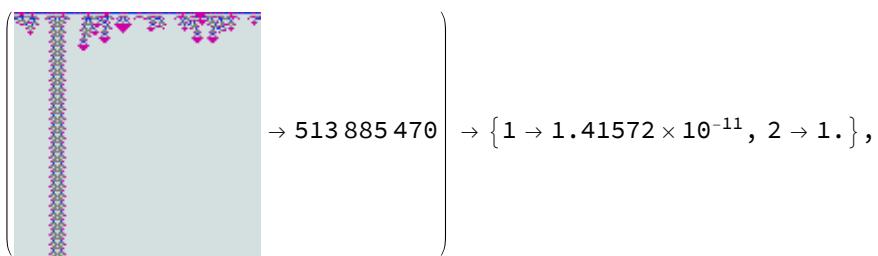
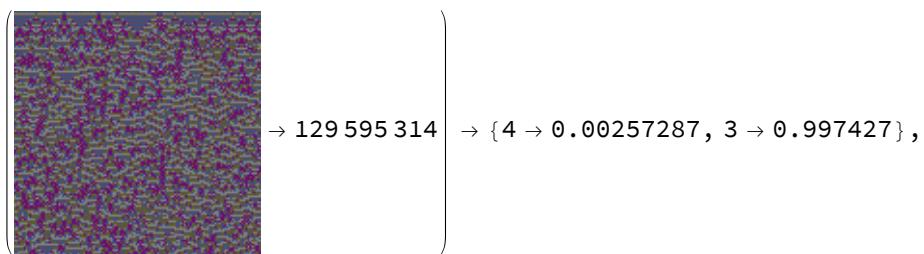
{ → 3 727 816 705} → {3 → 2.78599×10^{-7} , 4 → 1.},



5-colour totalistic, range 1

```
In[8]:= test4Data5kr1C16 = data5T2C[8, 128, 128];
Thread[
  test4Data5kr1C16 \[Function] netECA16[Keys@test4Data5kr1C16, {"TopProbabilities", 2}]]
```





6-colour totalistic, range 1

```
In[]:= test4Data6kr1C16 = data6TC[8, 128, 128];
Thread[
test4Data6kr1C16 → netECA16[Keys@test4Data6kr1C16, {"TopProbabilities", 2}]]
```

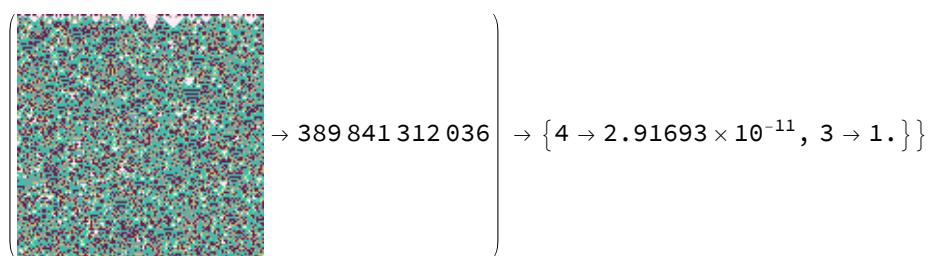
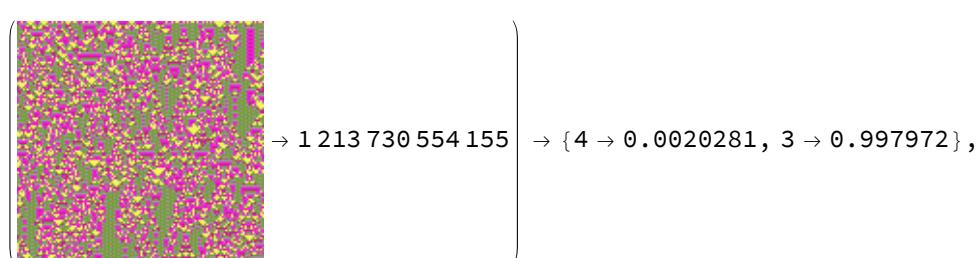
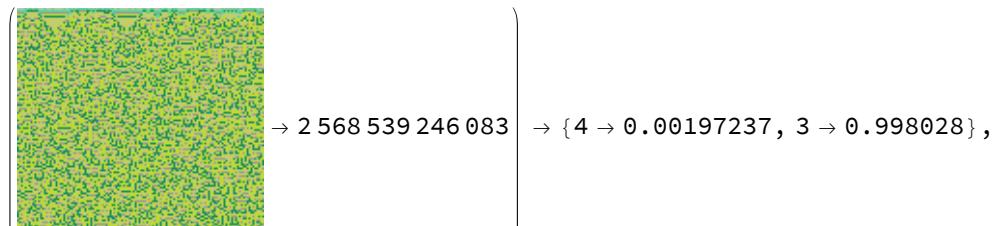
$$\text{Out}[]= \left\{ \begin{array}{l} \text{[A 128x128 grid of 6 colors (red, green, blue, cyan, magenta, yellow)]} \\ \rightarrow 1522715109251 \end{array} \right\} \rightarrow \{4 \rightarrow 2.02852 \times 10^{-8}, 3 \rightarrow 1.\},$$

$$\left\{ \begin{array}{l} \text{[A 128x128 grid of 6 colors (red, green, blue, cyan, magenta, yellow)]} \\ \rightarrow 1026953898330 \end{array} \right\} \rightarrow \{4 \rightarrow 2.88279 \times 10^{-8}, 3 \rightarrow 1.\},$$

$$\left\{ \begin{array}{l} \text{[A 128x128 grid of 6 colors (red, green, blue, cyan, magenta, yellow)]} \\ \rightarrow 1583652682 \end{array} \right\} \rightarrow \{3 \rightarrow 0.429972, 4 \rightarrow 0.570028\},$$

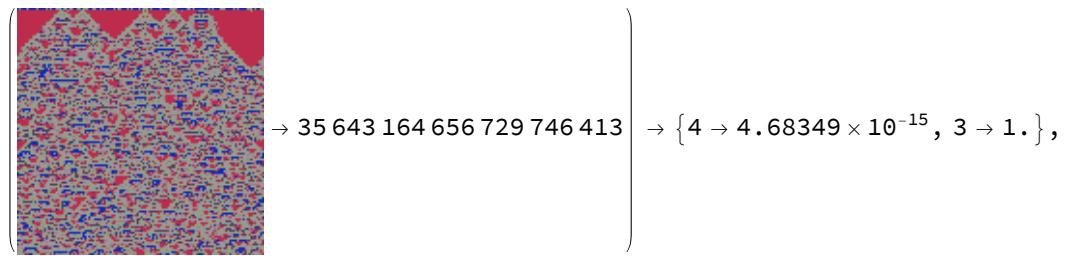
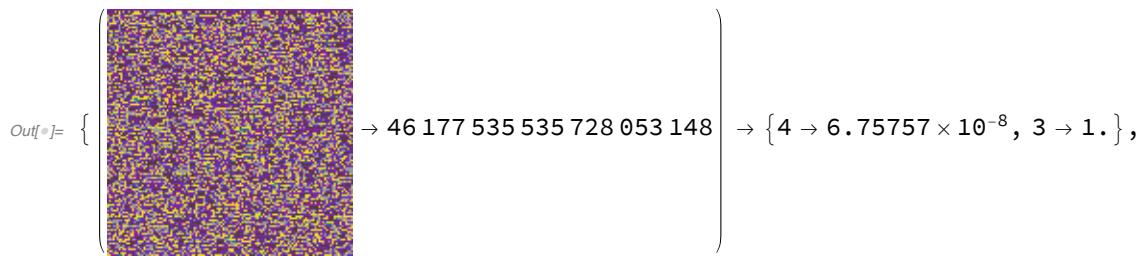
$$\left\{ \begin{array}{l} \text{[A 128x128 grid of 6 colors (red, green, blue, cyan, magenta, yellow)]} \\ \rightarrow 2123073201165 \end{array} \right\} \rightarrow \{4 \rightarrow 6.23239 \times 10^{-10}, 3 \rightarrow 1.\},$$

$$\left\{ \begin{array}{l} \text{[A 128x128 grid of 6 colors (red, green, blue, cyan, magenta, yellow)]} \\ \rightarrow 341591565791 \end{array} \right\} \rightarrow \{4 \rightarrow 0.00212154, 3 \rightarrow 0.997878\},$$



6-colour totalistic, range 2

```
In[]:= test4Data6kr2C16 = data6T2C[8, 128, 128];
Thread[
  test4Data6kr2C16 → netECA16[Keys@test4Data6kr2C16, {"TopProbabilities", 2}]]
```



$$\left(\begin{array}{c} \text{[A 4x4 grid of random colors]} \\ \rightarrow 151\ 294\ 335\ 263\ 255\ 298\ 785 \end{array} \right) \rightarrow \{4 \rightarrow 0.0673459, 3 \rightarrow 0.932654\},$$

$$\left(\begin{array}{c} \text{[A 4x4 grid of random colors]} \\ \rightarrow 8\ 803\ 703\ 818\ 914\ 948\ 546 \end{array} \right) \rightarrow \{4 \rightarrow 0.00560205, 3 \rightarrow 0.994398\},$$

$$\left(\begin{array}{c} \text{[A 4x4 grid of random colors]} \\ \rightarrow 46\ 723\ 275\ 025\ 483\ 150\ 950 \end{array} \right) \rightarrow \{4 \rightarrow 0.00307226, 3 \rightarrow 0.996928\},$$

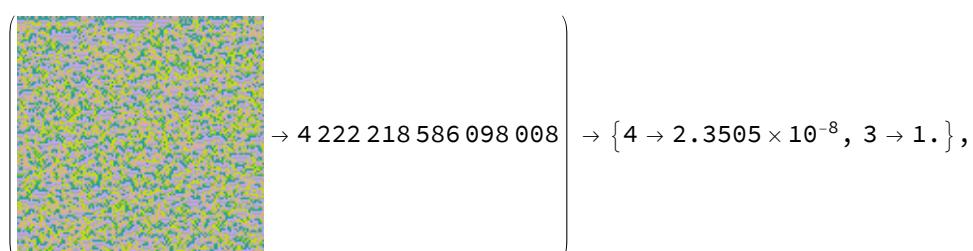
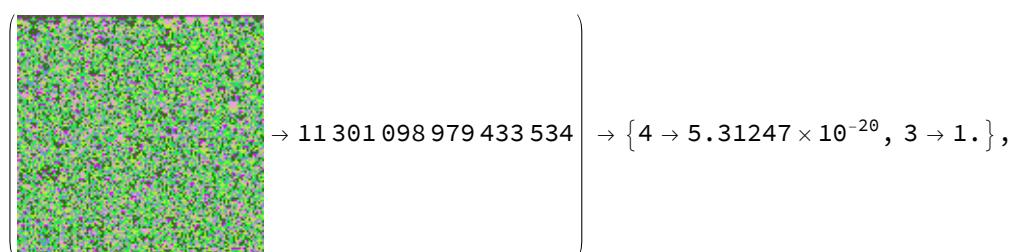
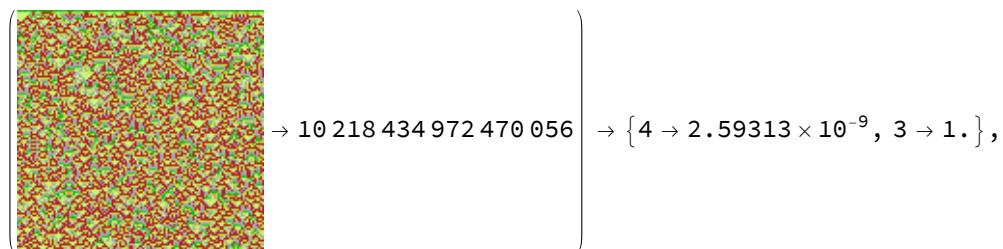
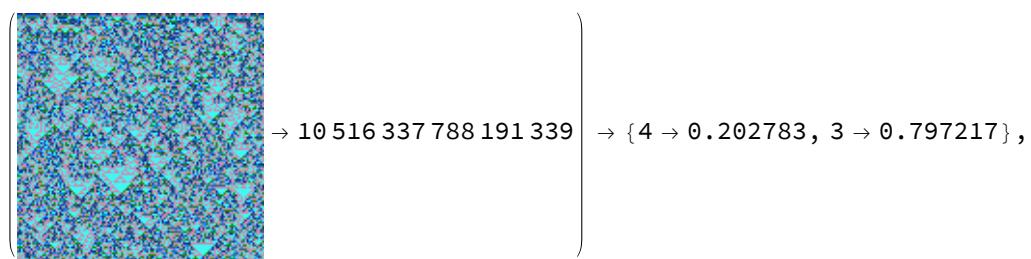
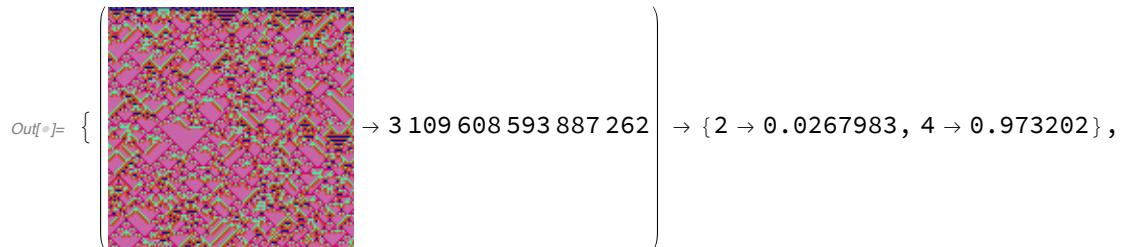
$$\left(\begin{array}{c} \text{[A 4x4 grid of random colors]} \\ \rightarrow 72\ 312\ 079\ 279\ 485\ 910\ 528 \end{array} \right) \rightarrow \{4 \rightarrow 0.00153324, 3 \rightarrow 0.998467\},$$

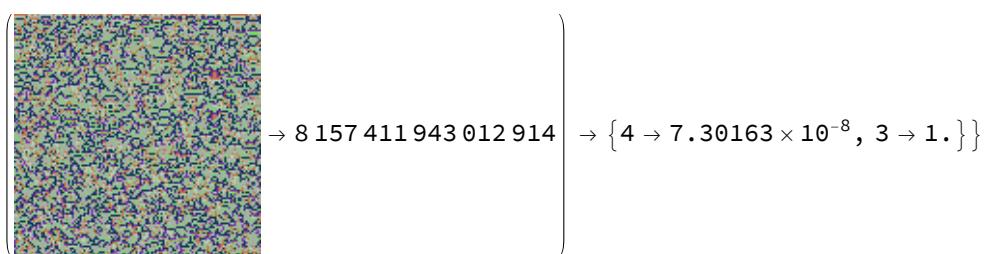
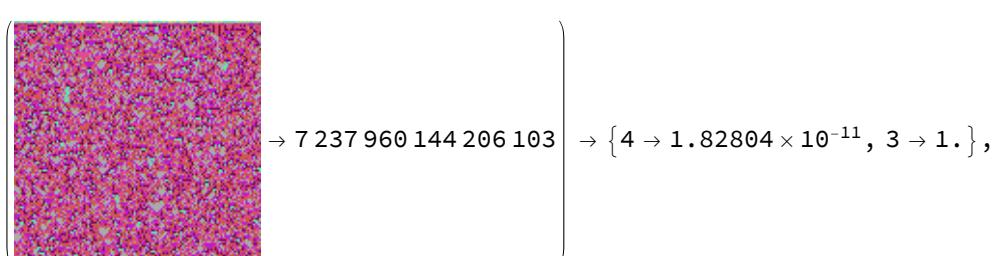
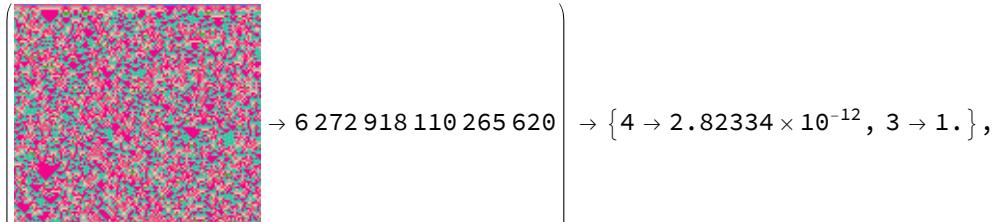
$$\left(\begin{array}{c} \text{[A 4x4 grid of random colors]} \\ \rightarrow 22\ 158\ 237\ 683\ 799\ 083\ 047 \end{array} \right) \rightarrow \{4 \rightarrow 3.51784 \times 10^{-13}, 3 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 4x4 grid of random colors]} \\ \rightarrow 142\ 446\ 781\ 366\ 136\ 429\ 283 \end{array} \right) \rightarrow \{4 \rightarrow 3.01302 \times 10^{-11}, 3 \rightarrow 1.\}$$

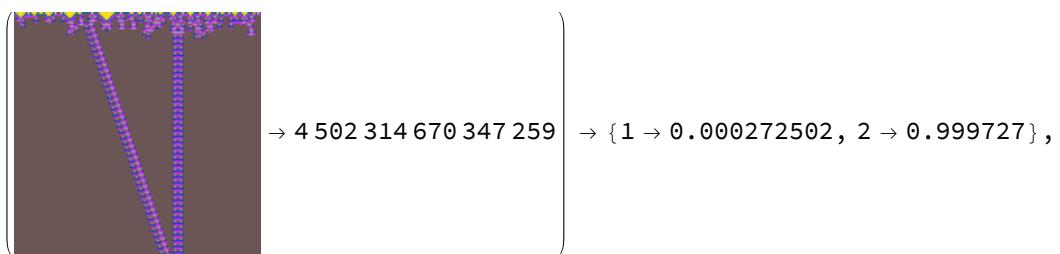
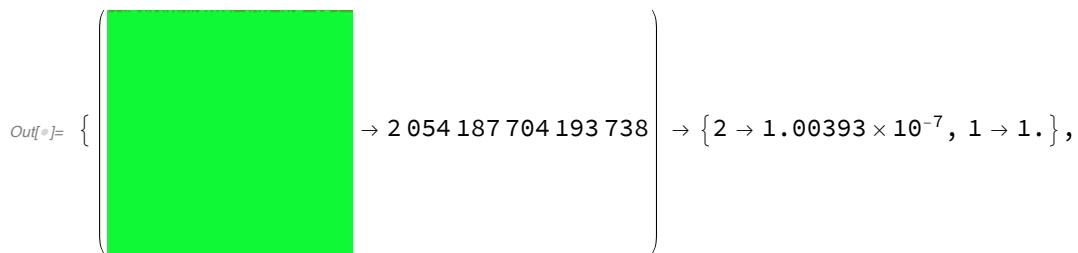
7-colour totalistic, range 1

```
In[]:= test4Data7kr1C16 = data7TC[8, 128, 128];
Thread[
  test4Data7kr1C16 → netECA16[Keys@test4Data7kr1C16, {"TopProbabilities", 2}]]
```





```
In[8]:= test4Data7kr1C16 = data7TC[8, 128, 128];
Thread[
  test4Data7kr1C16 → netECA16[Keys@test4Data7kr1C16, {"TopProbabilities", 2}]]
```



$$\left(\begin{array}{c} \text{[A 2x2 grid of random colors]} \\ \rightarrow 6\ 433\ 286\ 718\ 439\ 853 \end{array} \right) \rightarrow \left\{ 4 \rightarrow 3.57308 \times 10^{-13}, 3 \rightarrow 1. \right\},$$

$$\left(\begin{array}{c} \text{[A 2x2 grid of random colors]} \\ \rightarrow 10\ 115\ 271\ 094\ 201\ 812 \end{array} \right) \rightarrow \left\{ 4 \rightarrow 1.83956 \times 10^{-14}, 3 \rightarrow 1. \right\},$$

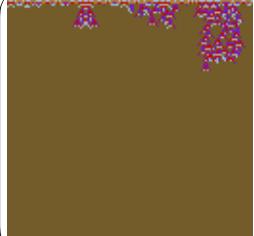
$$\left(\begin{array}{c} \text{[A 2x2 grid of random colors]} \\ \rightarrow 2\ 056\ 629\ 839\ 849\ 700 \end{array} \right) \rightarrow \left\{ 4 \rightarrow 7.03567 \times 10^{-6}, 2 \rightarrow 0.999993 \right\},$$

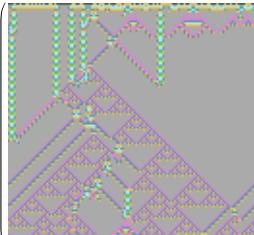
$$\left(\begin{array}{c} \text{[A 2x2 grid of random colors]} \\ \rightarrow 6\ 016\ 684\ 767\ 156\ 829 \end{array} \right) \rightarrow \left\{ 4 \rightarrow 0.0021258, 3 \rightarrow 0.997874 \right\},$$

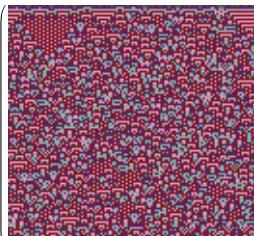
$$\left(\begin{array}{c} \text{[A 2x2 grid of random colors]} \\ \rightarrow 1\ 150\ 898\ 749\ 617\ 983 \end{array} \right) \rightarrow \left\{ 4 \rightarrow 5.05985 \times 10^{-9}, 3 \rightarrow 1. \right\},$$

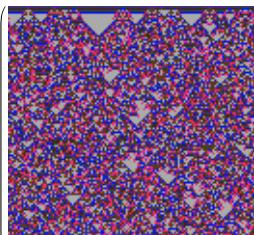
$$\left(\begin{array}{c} \text{[A 2x2 grid of random colors]} \\ \rightarrow 3\ 441\ 885\ 208\ 643\ 463 \end{array} \right) \rightarrow \left\{ 3 \rightarrow 1.57168 \times 10^{-8}, 2 \rightarrow 1. \right\}$$

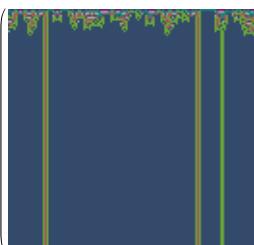
```
In[8]:= test4Data7kr1C16 = data7TC[8, 128, 128];
Thread[
  test4Data7kr1C16 → netECA16[Keys@test4Data7kr1C16, {"TopProbabilities", 2}]]
```

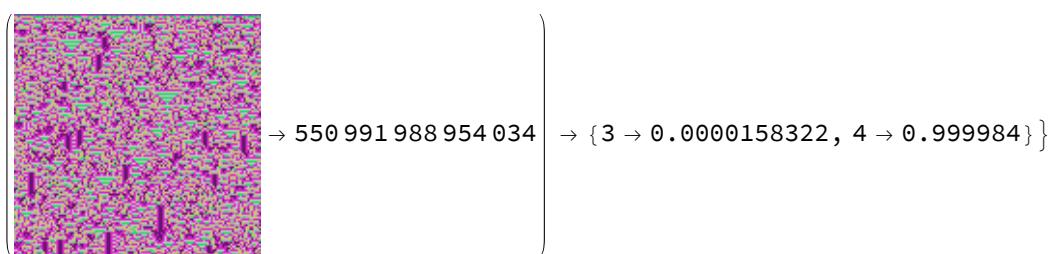
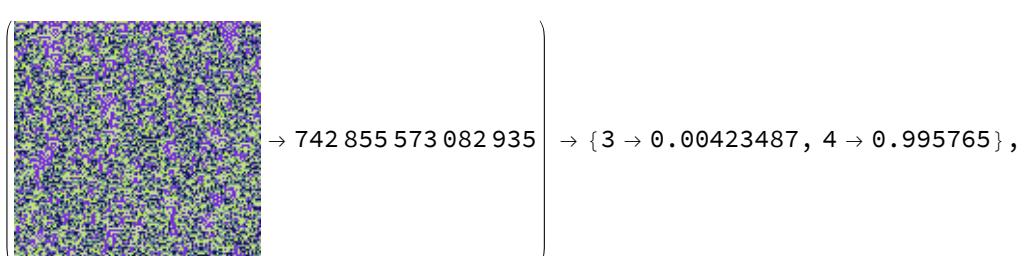
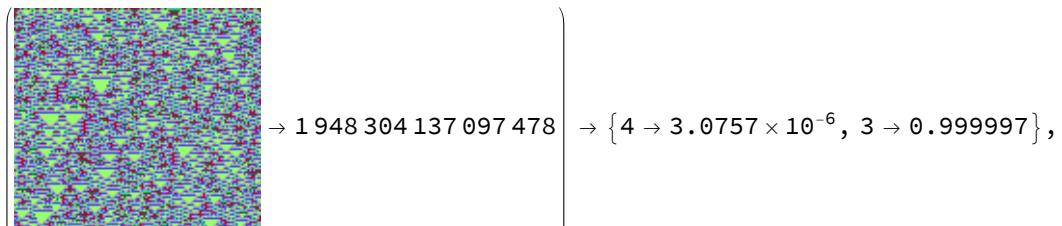
Out[8]= { → 8 718 538 805 570 808 } → {4 → 0.0199047, 2 → 0.980095},

{ → 5 687 458 247 703 346 } → {3 → 3.931 × 10⁻⁶, 4 → 0.999995},

{ → 2 004 300 484 518 722 } → {3 → 0.0438658, 4 → 0.956134},

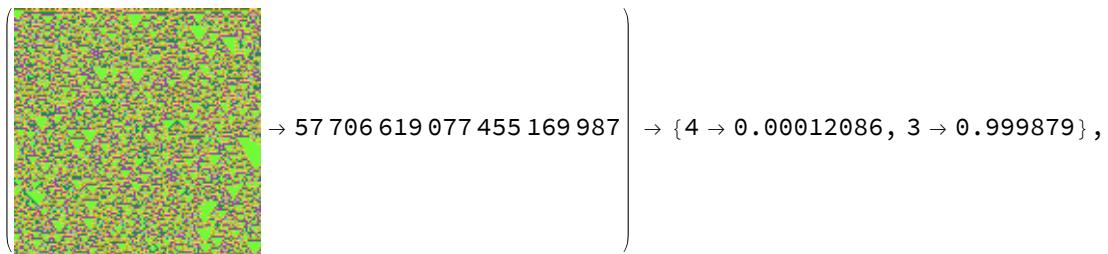
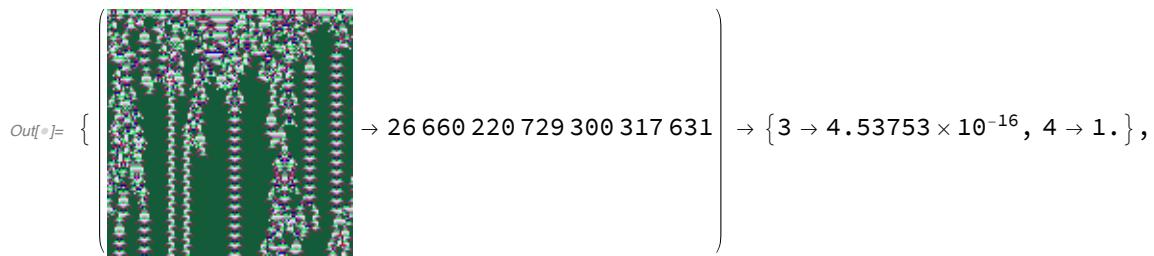
{ → 2 106 485 862 858 275 } → {4 → 3.36807 × 10⁻¹⁰, 3 → 1.},

{ → 10 335 102 717 390 268 } → {4 → 1.40275 × 10⁻⁹, 2 → 1.},



8-colour totalistic, range 1

```
In[]:= test4Data8kr1C16 = data8TC[8, 128, 128];
Thread[
  test4Data8kr1C16 → netECA16[Keys@test4Data8kr1C16, {"TopProbabilities", 2}]]
```



$$\left(\begin{array}{c} \text{[A 19x20 grid of random colors]} \\ \rightarrow 64\ 248\ 301\ 738\ 433\ 598\ 883 \end{array} \right) \rightarrow \{4 \rightarrow 8.62498 \times 10^{-7}, 3 \rightarrow 0.999999\},$$

$$\left(\begin{array}{c} \text{[A 19x20 grid of random colors]} \\ \rightarrow 38\ 309\ 191\ 234\ 358\ 472\ 181 \end{array} \right) \rightarrow \{3 \rightarrow 0.0920227, 4 \rightarrow 0.907977\},$$

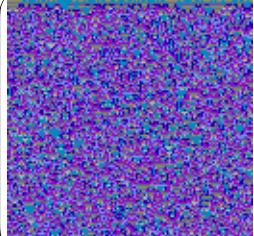
$$\left(\begin{array}{c} \text{[A 19x20 grid of random colors]} \\ \rightarrow 10\ 057\ 418\ 236\ 647\ 939\ 786 \end{array} \right) \rightarrow \{3 \rightarrow 0.00153869, 4 \rightarrow 0.998461\},$$

$$\left(\begin{array}{c} \text{[A 19x20 grid of random colors]} \\ \rightarrow 55\ 038\ 816\ 396\ 722\ 824\ 044 \end{array} \right) \rightarrow \{4 \rightarrow 7.93818 \times 10^{-11}, 3 \rightarrow 1.\},$$

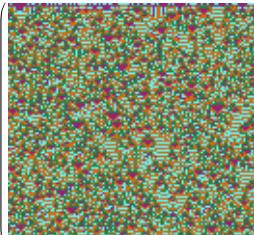
$$\left(\begin{array}{c} \text{[A 19x20 grid of random colors]} \\ \rightarrow 13\ 857\ 790\ 822\ 319\ 662\ 750 \end{array} \right) \rightarrow \{4 \rightarrow 1.6375 \times 10^{-9}, 2 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 19x20 grid of random colors]} \\ \rightarrow 35\ 001\ 739\ 471\ 058\ 241\ 746 \end{array} \right) \rightarrow \{3 \rightarrow 0.146189, 4 \rightarrow 0.853811\}$$

```
In[8]:= test4Data8kr1C16 = data8TC[8, 128, 128];
Thread[
  test4Data8kr1C16 → netECA16[Keys@test4Data8kr1C16, {"TopProbabilities", 2}]]
```

Out[8]= { → 8 889 571 206 431 822 669}

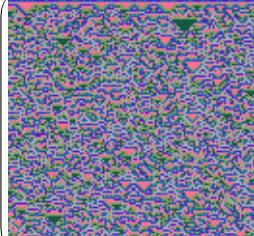
$$\rightarrow \{4 \rightarrow 7.71651 \times 10^{-13}, 3 \rightarrow 1.\},$$

 → 12 932 107 158 159 577 869

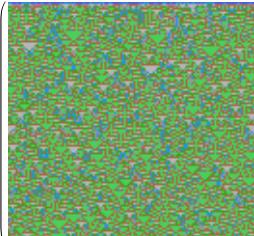
$$\rightarrow \{4 \rightarrow 0.000487127, 3 \rightarrow 0.999513\},$$

 → 38 300 014 541 797 689 408

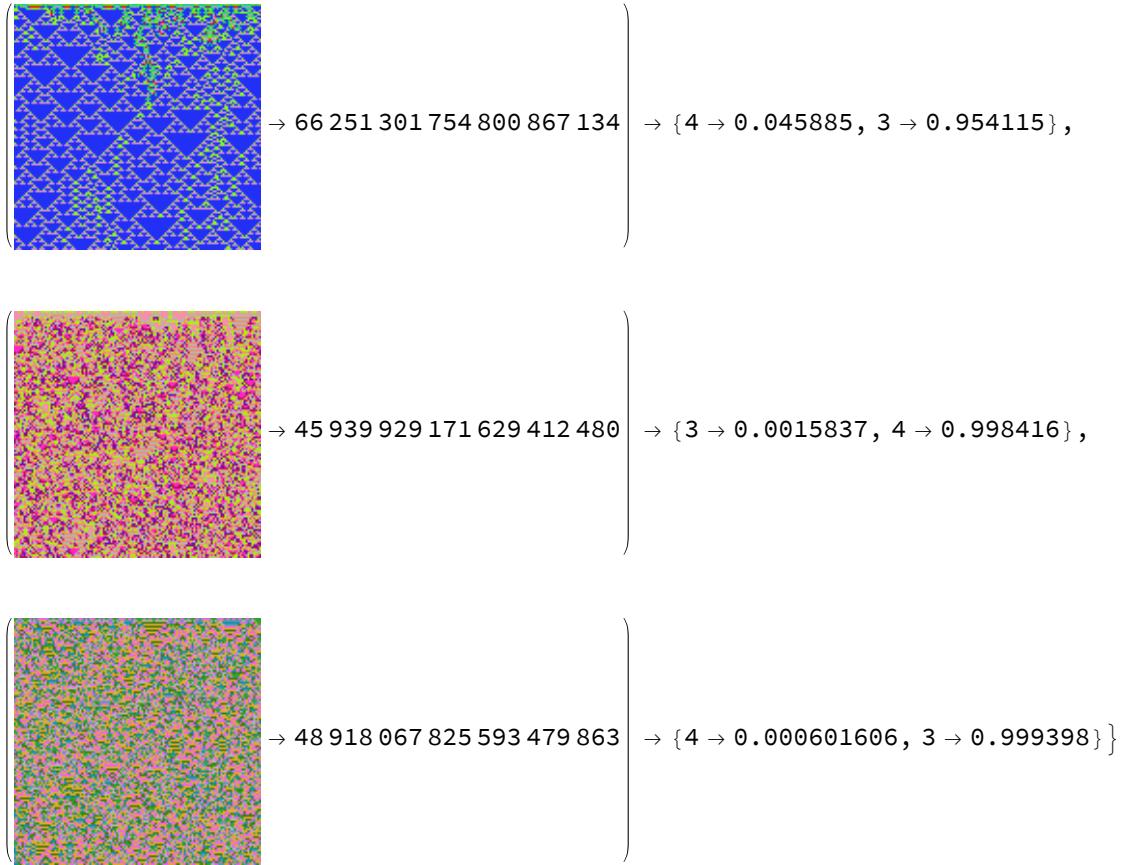
$$\rightarrow \{2 \rightarrow 4.40131 \times 10^{-9}, 4 \rightarrow 1.\},$$

 → 73 619 662 786 582 031 542

$$\rightarrow \{4 \rightarrow 2.6954 \times 10^{-22}, 3 \rightarrow 1.\},$$

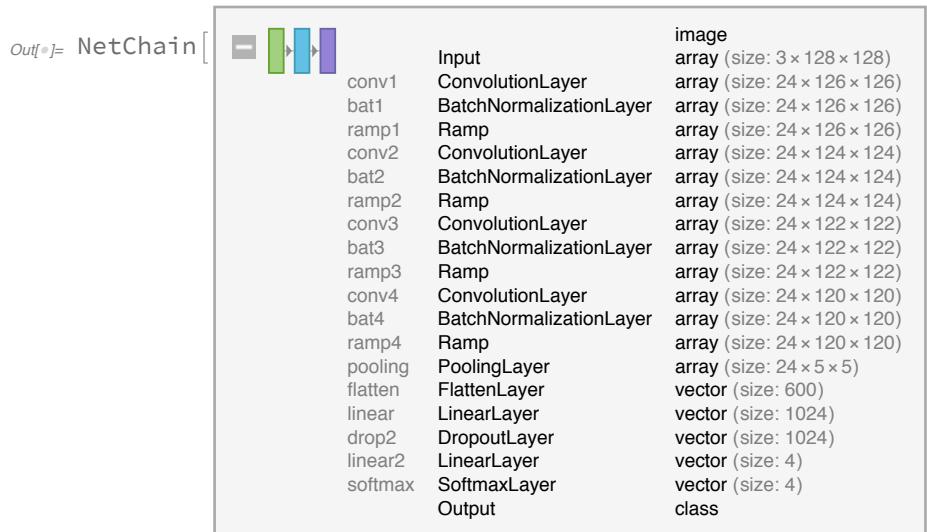
 → 25 075 664 454 379 326 631

$$\rightarrow \{4 \rightarrow 2.7484 \times 10^{-6}, 3 \rightarrow 0.999997\},$$

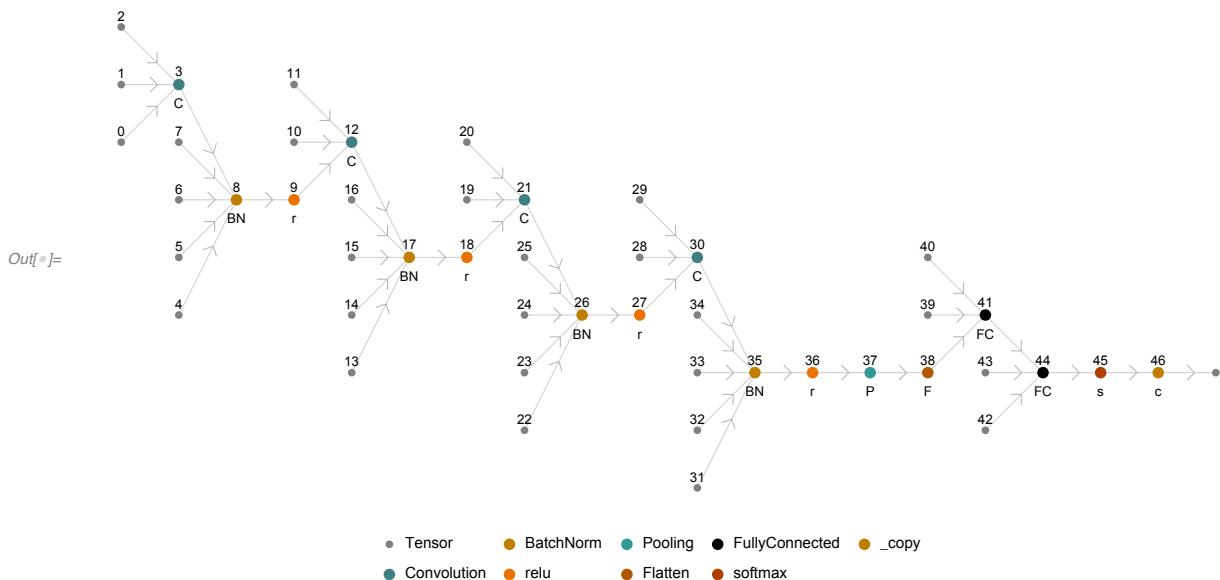


Network XVII - Four convolutions, dropout on linear only, BatchNorm

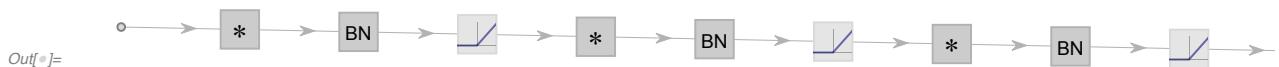
```
In[6]:= netECA17 = netTenCC1024drop[128, 128]
```



In[1]:= NetInformation[netECA17, "MXNetNodeGraphPlot"]



In[2]:= NetInformation[netECA17, "SummaryGraphic"]



In[3]:= dataECA17 = dataC[128, 128, 16 384];

In[4]:= dataTotalistic2BigC17 = genData2r2C[128, 128, 2048];

In[5]:= dataTotalistic3BigC17 = data3T2C[128, 128, 2048];

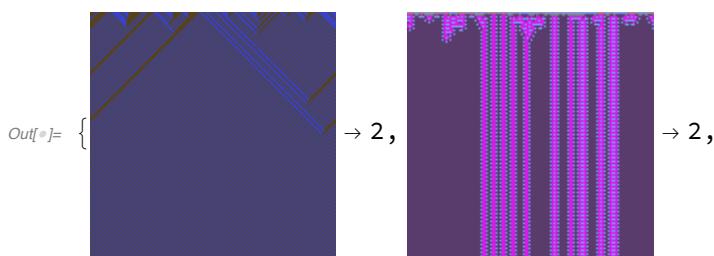
In[6]:= dataTotalistic4BigC17 = data4TC[128, 128, 2048];

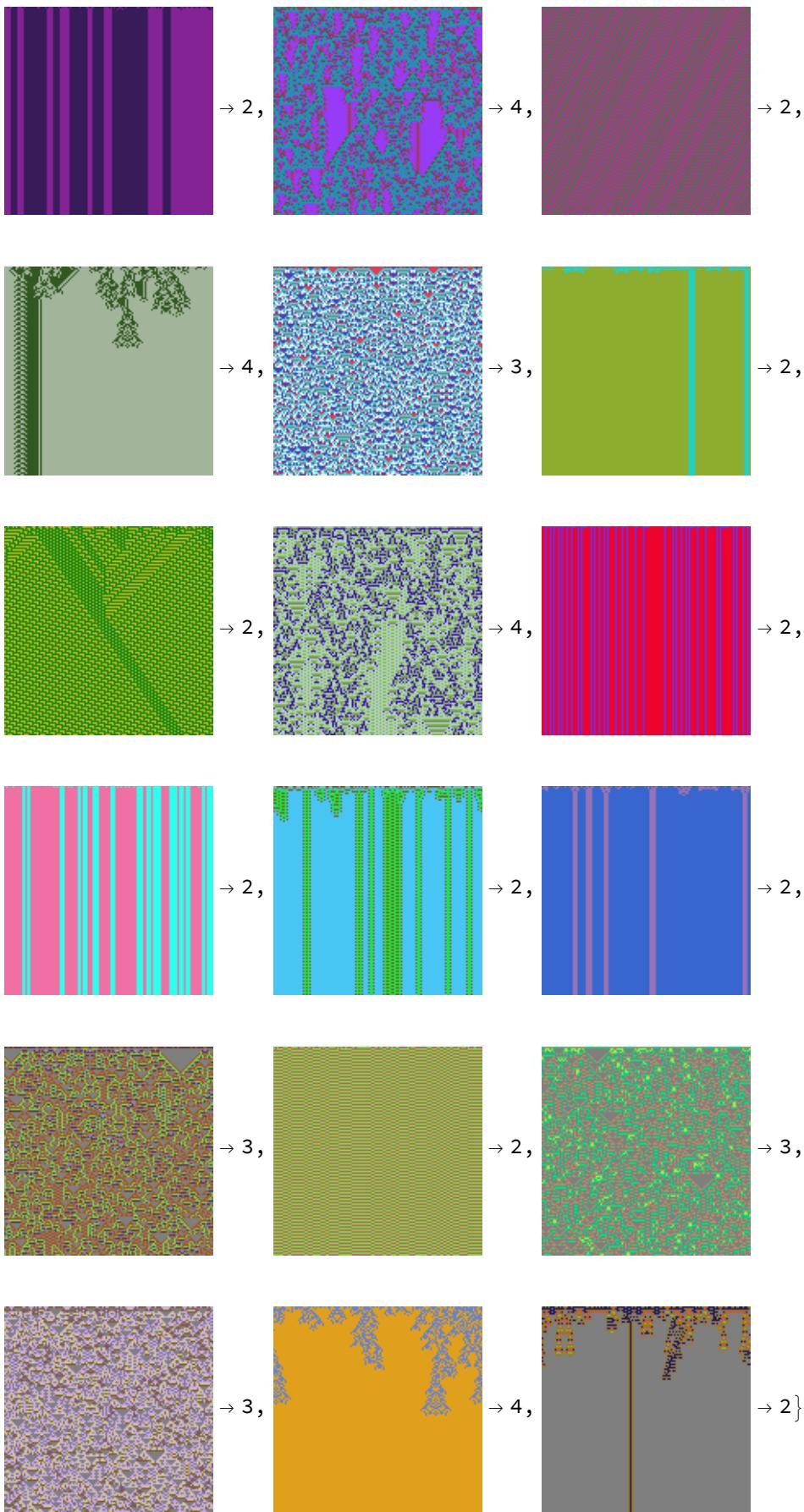
In[7]:= dataTotalistic5BigC17 = genData5TCC[128, 128, 8192];

In[8]:= fullTrainingBigC17 = Join[dataECA17, dataTotalistic2BigC17,
dataTotalistic3BigC17, dataTotalistic4BigC17, dataTotalistic5BigC17];
Length[fullTrainingBigC17]

Out[8]= 53 248

In[9]:= RandomSample[fullTrainingBigC17, 20]





```
In[®]:= dir = SetDirectory[NotebookDirectory[]]
In[®]:= "/home/esilverman/Documents"
Out[®]= /home/esilverman/Documents

In[®]:= netECA17 = NetTrain[netECA17, fullTrainingBigC17,
  MaxTrainingRounds → 200, BatchSize → 256, TargetDevice → "GPU",
  TrainingProgressCheckpointing → {"Directory", dir}]
```

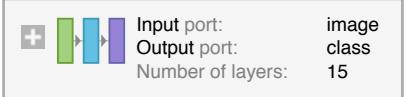
Out[®]= NetChain[]

```
netECA17 = Import["netECA17-r200.wlnet"]
```

Generate test data for Network XVII (200 epochs)

```
In[®]:= dir = SetDirectory[NotebookDirectory[]]
Out[®]= /Users/thorsilver/Downloads/Wolfram notebooks
```

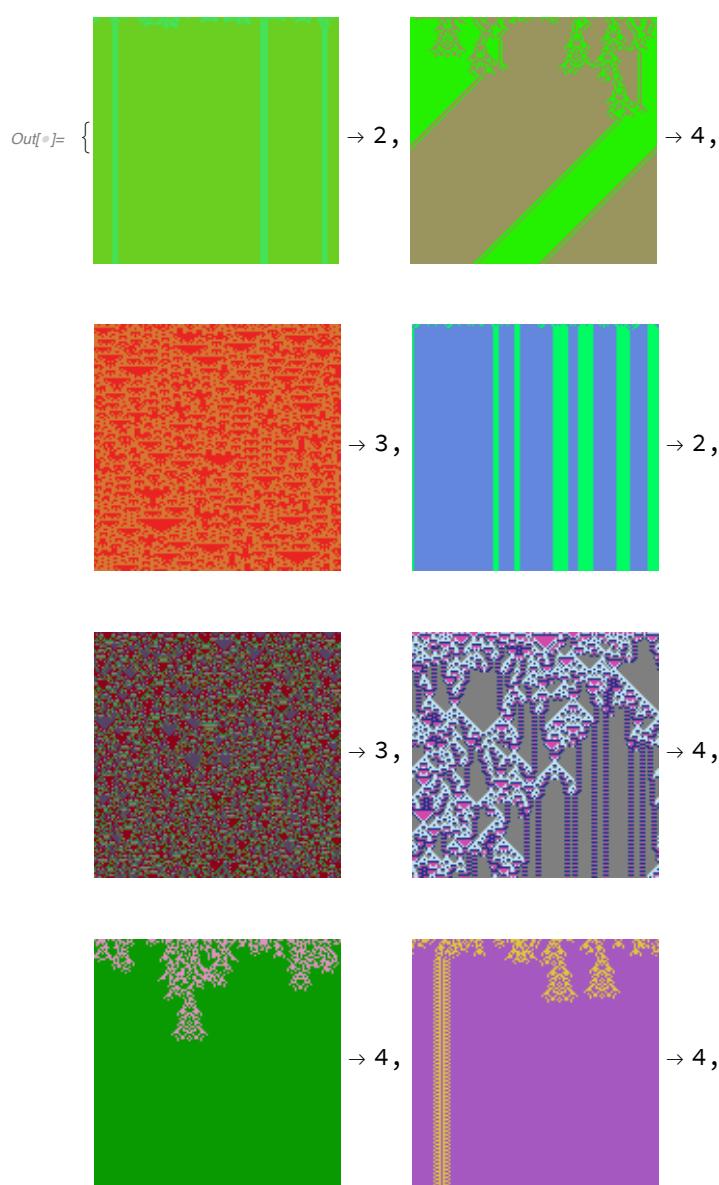
```
netECA17 = Import["netECA17-r200.wlnet"]
```

Out[®]= NetChain[]

```
In[®]:= testDataECABigC = dataC[128, 128, 1024];
testData2TBigC = genData2r2C[128, 128, 1024];
testData3TBigC = data3T2C[128, 128, 1024];
testData4TBigC = data4TC[128, 128, 1024];
testData5TBigC = genData5TCC[128, 128, 1024];
fullTestSetBigC = Join[testDataECABigC,
  testData2TBigC, testData3TBigC, testData4TBigC, testData5TBigC];
Length[fullTestSetBigC]
```

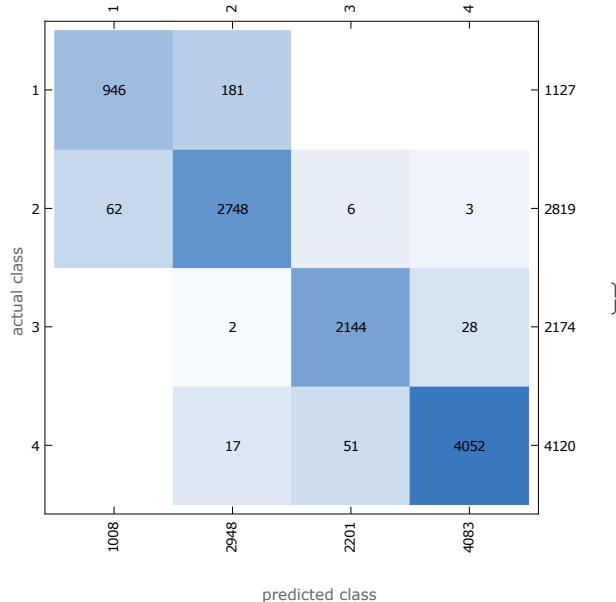
Out[®]= 10 240

In[8]:= RandomSample[fullTestSetBigC, 10]

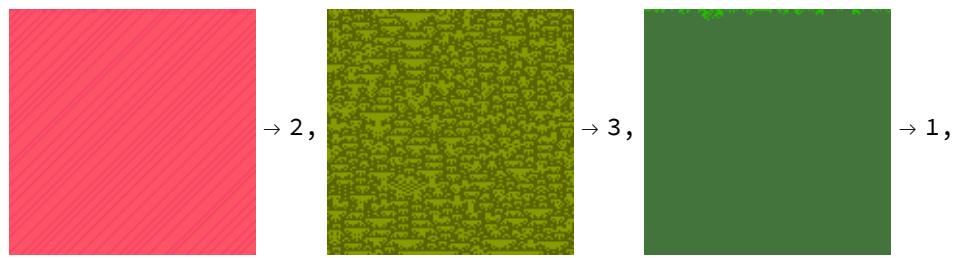
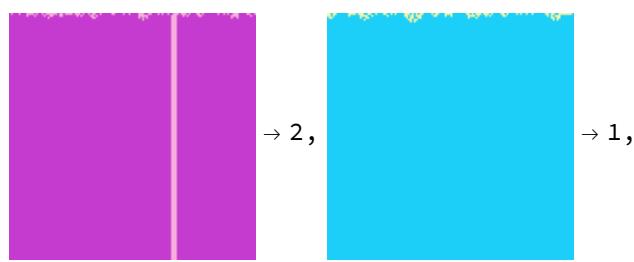
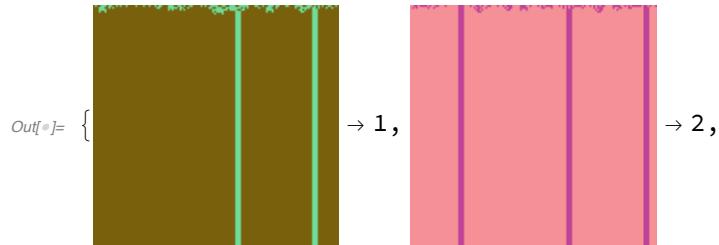


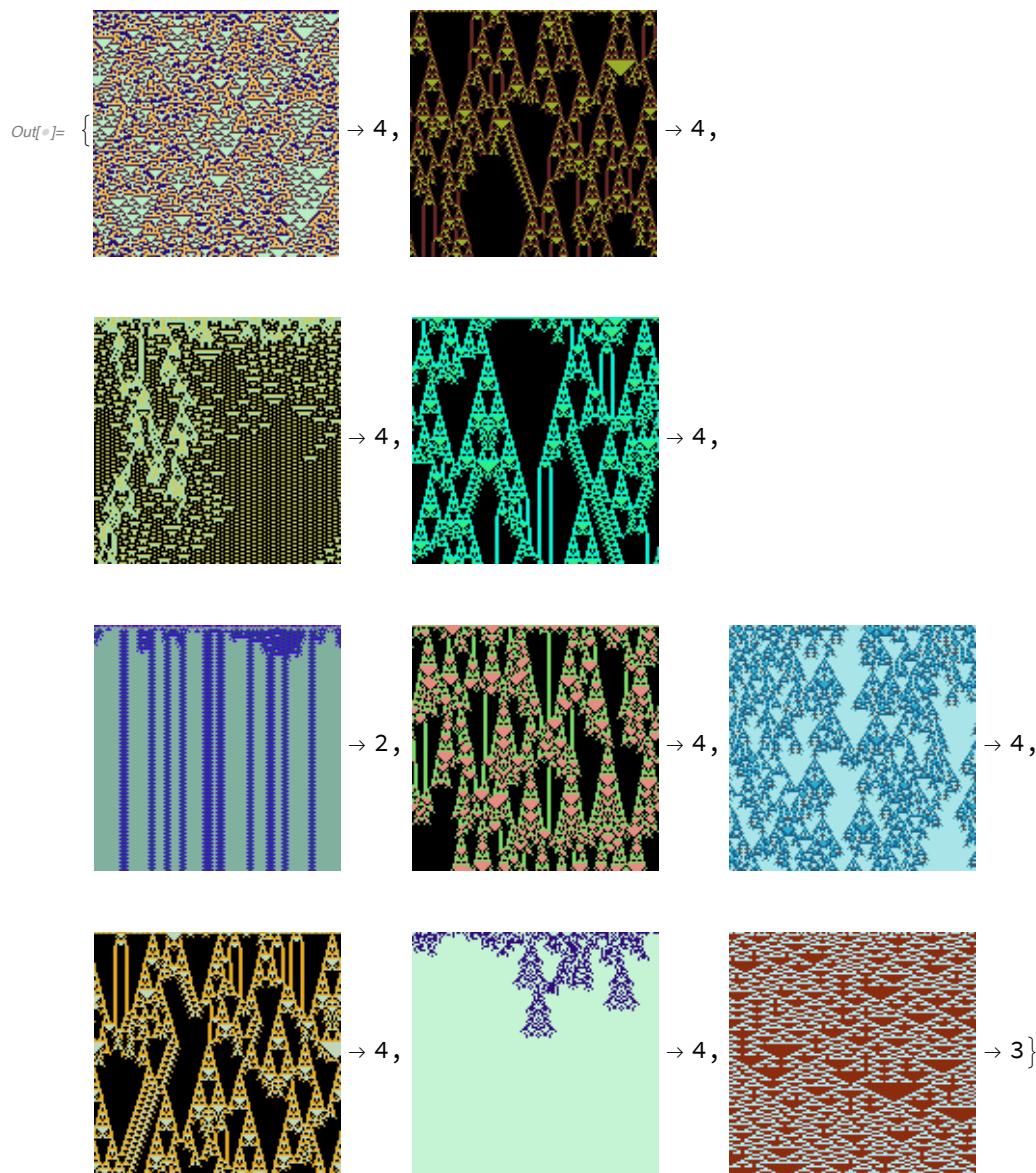
```
In[®]:= NetMeasurements[netECA17, fullTestSetBigC,
 {"Accuracy", "Precision", "ConfusionMatrixPlot"}]

Out[®]= {0.96582, {1 → 0.938492, 2 → 0.932157, 3 → 0.974103, 4 → 0.992408}, }
```



```
In[®]:= entropyImagesBigC = RandomSample[Keys[fullTestSetBigC], 500];
entropiesBigC = netECA17[entropyImagesBigC, "Entropy"];
highEntBigC = entropyImagesBigC[[Ordering[entropiesBigC, -10]]];
lowEntBigC = entropyImagesBigC[[Ordering[entropiesBigC, 10]]];
Thread[highEntBigC → netECA17[highEntBigC]]
Thread[lowEntBigC → netECA17[lowEntBigC]]
```





Testing Network XVII (200 epochs) on unseen CA rule spaces

2-colour non-totalistic, range 2

```
In[•]:= test4Data2kr2C17 = datak2r2C[128, 128, 8];
Thread[
  test4Data2kr2C17 → netECA17[Keys@test4Data2kr2C17, {"TopProbabilities", 2}]]
```

Out[•]:= {

→ 3 594 886 935 → {3 → 1.19587 × 10⁻⁷, 2 → 1. } ,

$$\left(\begin{array}{c} \text{[A 2x2 grid of yellow pixels]} \\ \rightarrow 4\ 012\ 014\ 789 \end{array} \right) \rightarrow \{ 4 \rightarrow 0.00317589, 3 \rightarrow 0.996824 \},$$

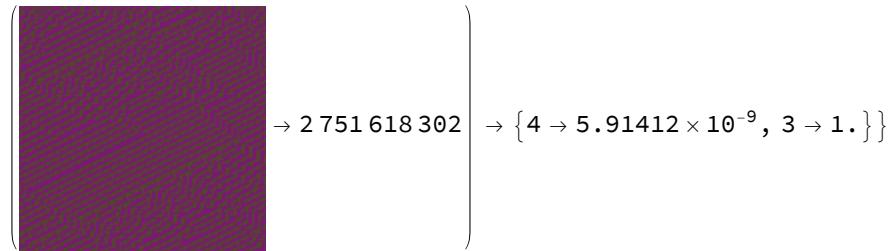
$$\left(\begin{array}{c} \text{[A 2x2 grid of red/pink pixels]} \\ \rightarrow 736\ 342\ 145 \end{array} \right) \rightarrow \{ 4 \rightarrow 0.000138652, 3 \rightarrow 0.999861 \},$$

$$\left(\begin{array}{c} \text{[A 2x2 grid of vertical blue/yellow bars]} \\ \rightarrow 3\ 597\ 938\ 931 \end{array} \right) \rightarrow \{ 4 \rightarrow 5.42024 \times 10^{-16}, 2 \rightarrow 1. \},$$

$$\left(\begin{array}{c} \text{[A 2x2 grid of horizontal blue/black bars]} \\ \rightarrow 49\ 406\ 137 \end{array} \right) \rightarrow \{ 1 \rightarrow 4.03179 \times 10^{-30}, 2 \rightarrow 1. \},$$

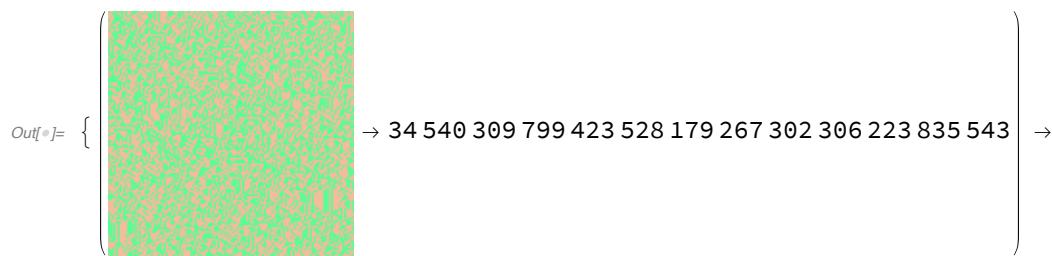
$$\left(\begin{array}{c} \text{[A 2x2 grid of green diagonal lines]} \\ \rightarrow 669\ 500\ 034 \end{array} \right) \rightarrow \{ 4 \rightarrow 0.0129747, 2 \rightarrow 0.983657 \},$$

$$\left(\begin{array}{c} \text{[A 2x2 grid of cyan/magenta vertical bars]} \\ \rightarrow 4\ 122\ 605\ 661 \end{array} \right) \rightarrow \{ 1 \rightarrow 6.18382 \times 10^{-9}, 2 \rightarrow 1. \},$$

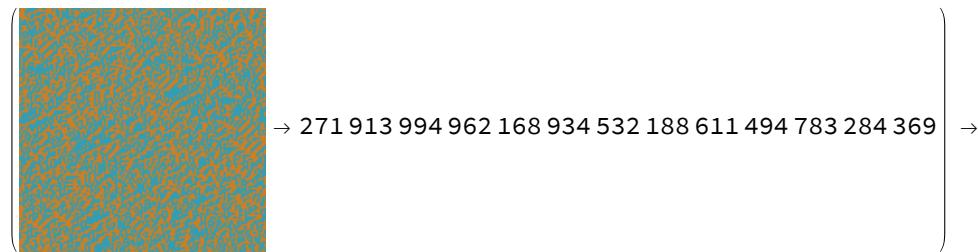


2-colour non-totalistic, range 3

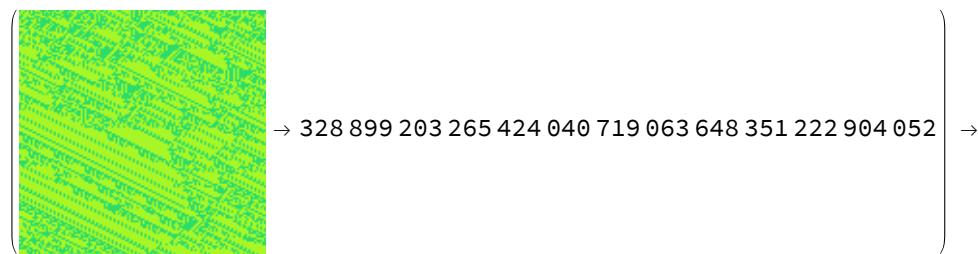
```
In[6]:= test4Data2kr3C17 = datak2r3NT[128, 128, 8];
Thread[
test4Data2kr3C17 → netECA17[Keys@test4Data2kr3C17, {"TopProbabilities", 2}]]
```



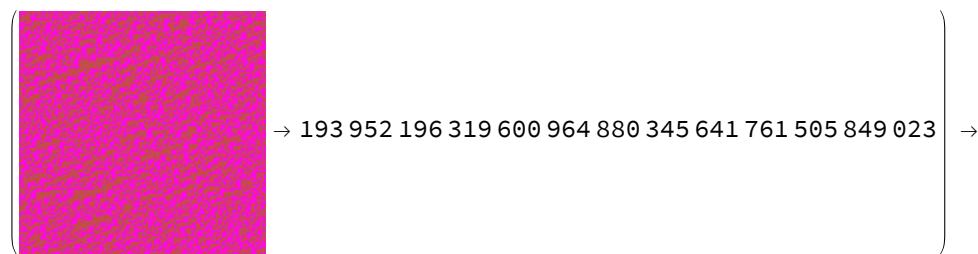
{4 → 0.0000190167, 3 → 0.999981},

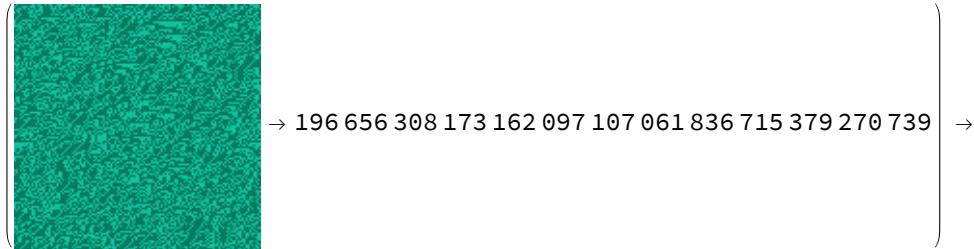
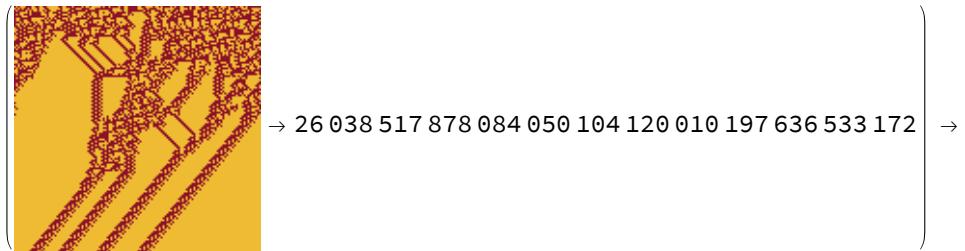
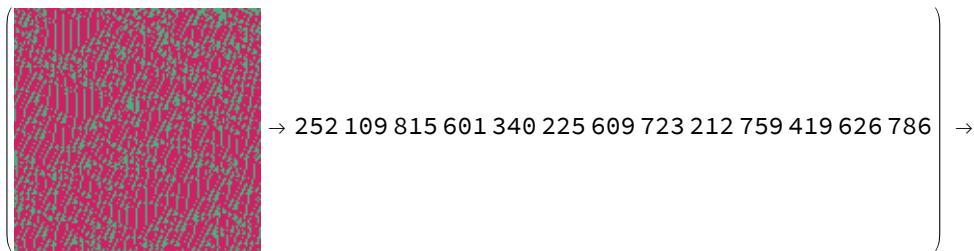
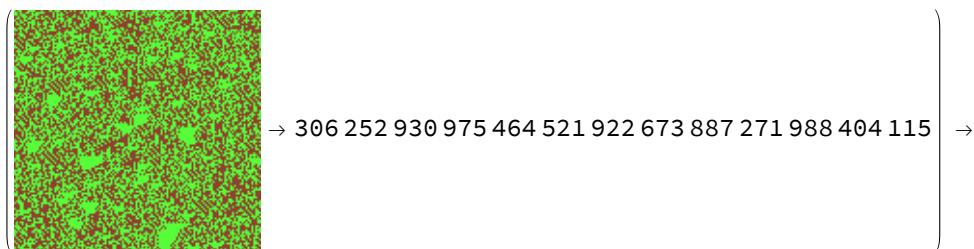


{4 → 8.79258 × 10⁻¹⁵, 3 → 1.},



{3 → 0.000609094, 4 → 0.999391},



$\{4 \rightarrow 8.96571 \times 10^{-10}, 3 \rightarrow 1.\},$

 $\{4 \rightarrow 3.36397 \times 10^{-6}, 3 \rightarrow 0.999997\},$

 $\{3 \rightarrow 5.4757 \times 10^{-7}, 4 \rightarrow 0.999999\},$

 $\{4 \rightarrow 1.35911 \times 10^{-8}, 3 \rightarrow 1.\},$

 $\{4 \rightarrow 5.68649 \times 10^{-7}, 3 \rightarrow 0.999999\}\}$

3-colour non-totalistic, range 1

```
In[6]:= test4Data3kr1C17 = datak3r1NT[128, 128, 8];
Thread[
test4Data3kr1C17 → netECA17[Keys@test4Data3kr1C17, {"TopProbabilities", 2}]]
```

$$Out[1]= \left\{ \begin{array}{c} \text{(A 2D grid pattern)} \\ \rightarrow 1924646489567 \end{array} \right\} \rightarrow \{3 \rightarrow 1.76606 \times 10^{-30}, 2 \rightarrow 1.\},$$

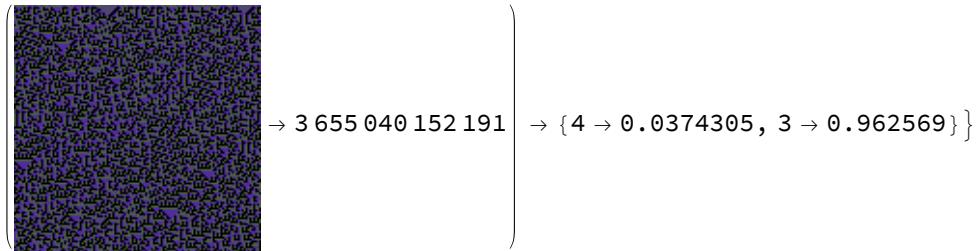
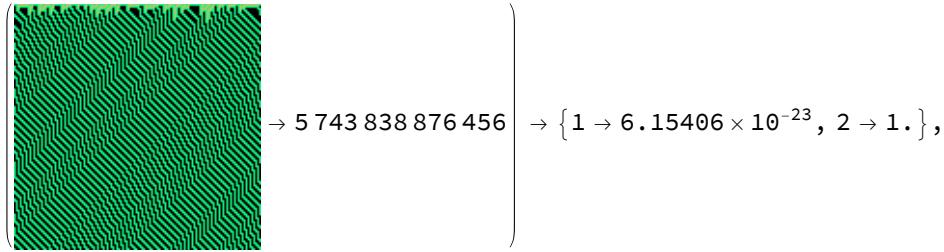
$$\left\{ \begin{array}{c} \text{(A 2D grid pattern)} \\ \rightarrow 3672534501071 \end{array} \right\} \rightarrow \{2 \rightarrow 0.0000110699, 4 \rightarrow 0.999989\},$$

$$\left\{ \begin{array}{c} \text{(A 2D grid pattern)} \\ \rightarrow 5833330297781 \end{array} \right\} \rightarrow \{2 \rightarrow 0.000232935, 4 \rightarrow 0.999767\},$$

$$\left\{ \begin{array}{c} \text{(A solid black square)} \\ \rightarrow 7606192973798 \end{array} \right\} \rightarrow \{2 \rightarrow 6.802 \times 10^{-10}, 1 \rightarrow 1.\},$$

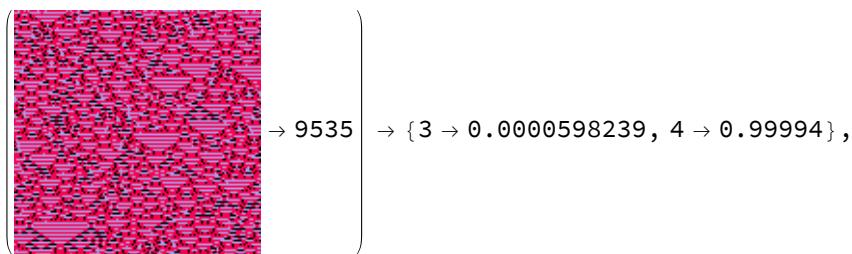
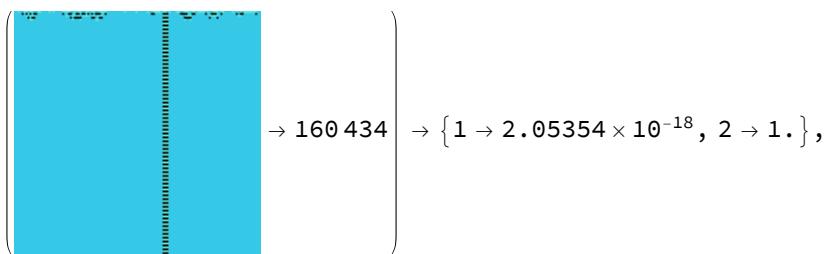
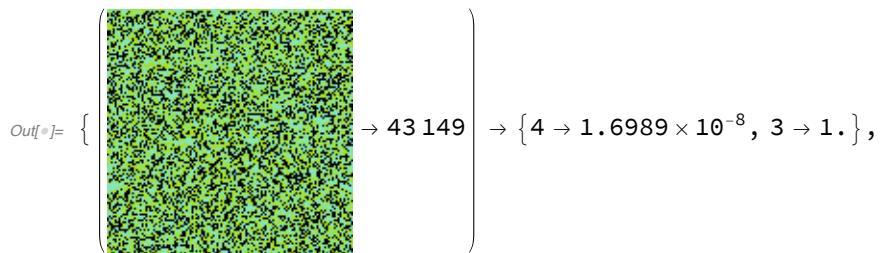
$$\left\{ \begin{array}{c} \text{(A 2D grid pattern)} \\ \rightarrow 7622301560954 \end{array} \right\} \rightarrow \{3 \rightarrow 0.0391643, 2 \rightarrow 0.960836\},$$

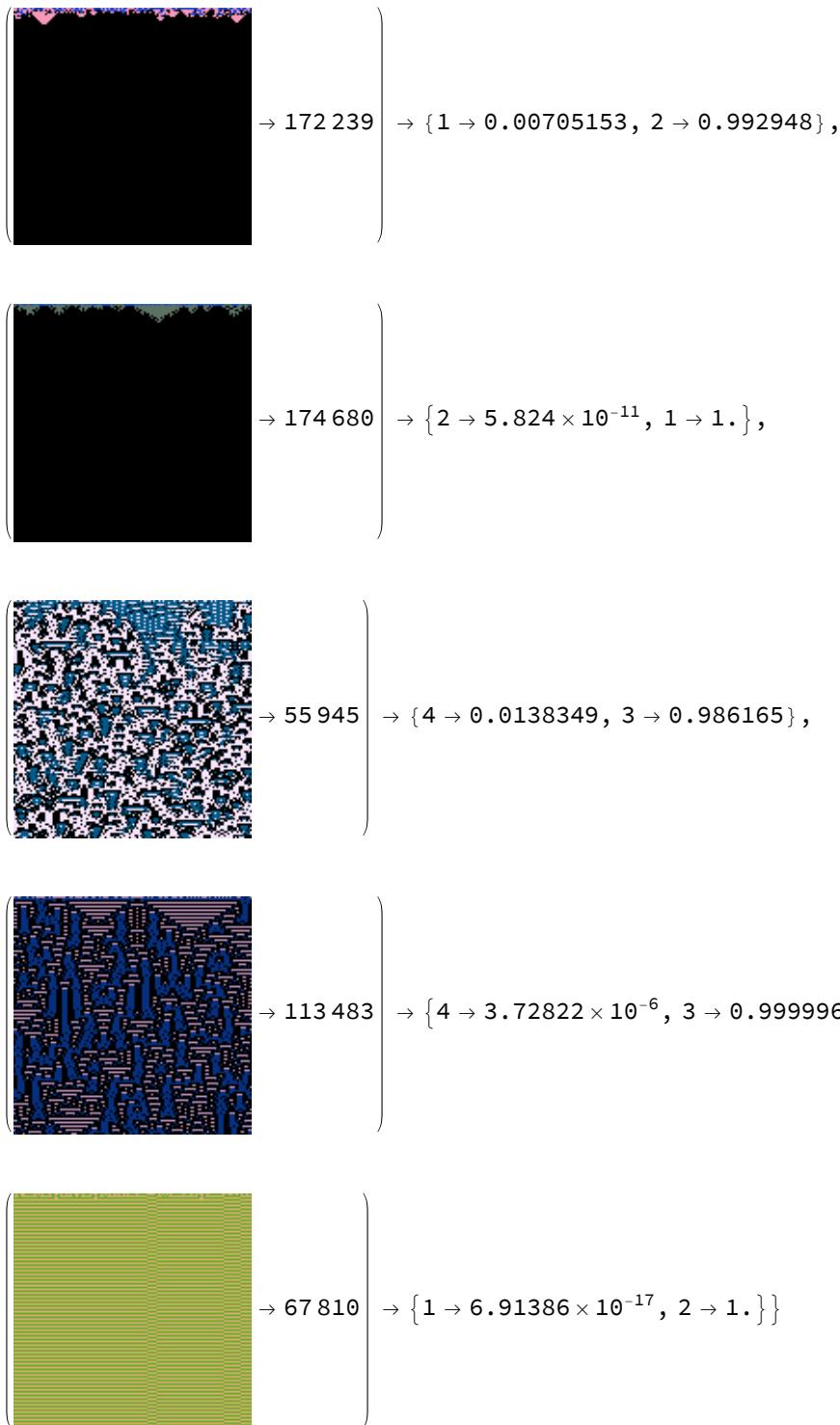
$$\left\{ \begin{array}{c} \text{(A 2D grid pattern)} \\ \rightarrow 3685910174297 \end{array} \right\} \rightarrow \{3 \rightarrow 2.7602 \times 10^{-8}, 4 \rightarrow 1.\},$$



3-colour totalistic, range 2

```
In[]:= test4Data3kr2C17 = datak3r2C[128, 128, 8];
Thread[
  test4Data3kr2C17 > netECA17[Keys@test4Data3kr2C17, {"TopProbabilities", 2}]]
```





3-colour totalistic, range 3

```
In[⑩]:= test4Data3kr3C17 = datak3r3C[128, 128, 8];
Thread[
test4Data3kr3C17 → netECA17[Keys@test4Data3kr3C17, {"TopProbabilities", 2}]]
```

Out[•]= $\left\{ \begin{array}{c} \text{[A green noise pattern]} \\ \rightarrow 3\ 046\ 610 \end{array} \right\} \rightarrow \{4 \rightarrow 7.58312 \times 10^{-7}, 3 \rightarrow 0.999999\},$

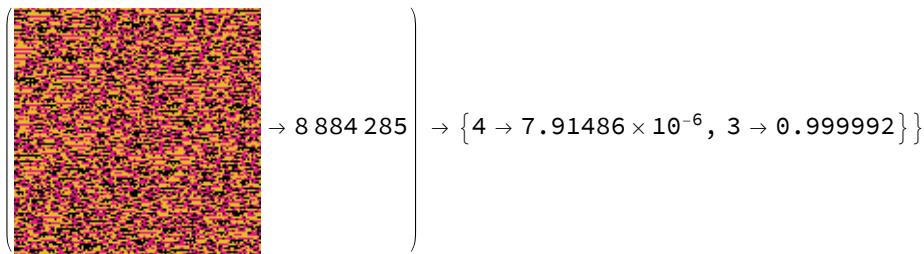
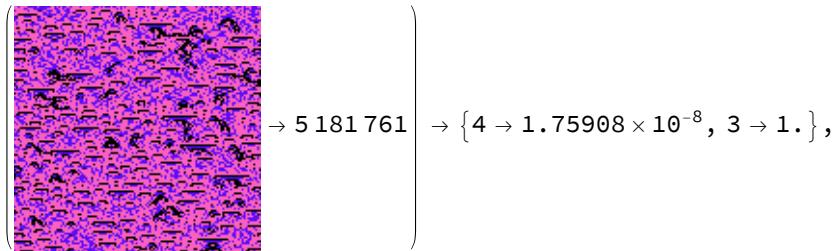
$\left\{ \begin{array}{c} \text{[A blue pattern with vertical black lines]} \\ \rightarrow 7\ 801\ 434 \end{array} \right\} \rightarrow \{1 \rightarrow 1.19167 \times 10^{-14}, 2 \rightarrow 1.\},$

$\left\{ \begin{array}{c} \text{[A blue pattern with horizontal black lines]} \\ \rightarrow 5\ 445\ 843 \end{array} \right\} \rightarrow \{4 \rightarrow 1.60992 \times 10^{-19}, 3 \rightarrow 1.\},$

$\left\{ \begin{array}{c} \text{[A purple noise pattern]} \\ \rightarrow 1\ 451\ 413 \end{array} \right\} \rightarrow \{4 \rightarrow 0.144413, 3 \rightarrow 0.855587\},$

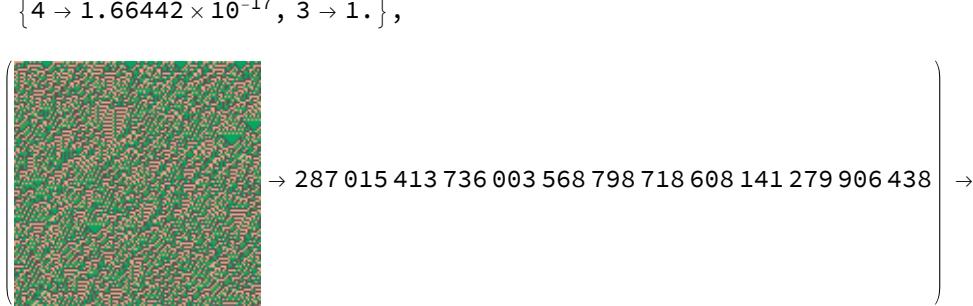
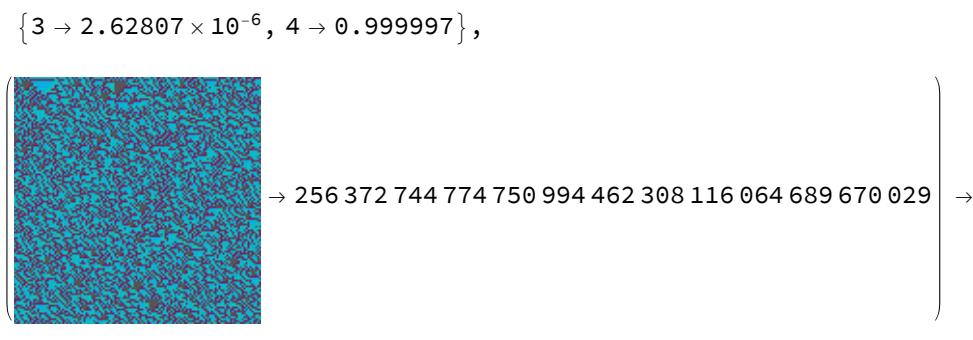
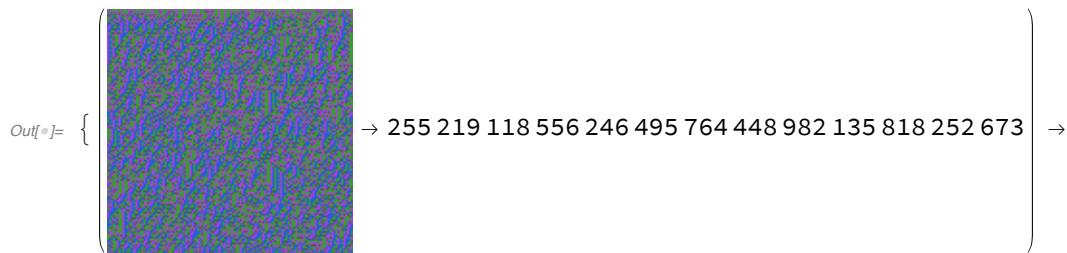
$\left\{ \begin{array}{c} \text{[A brown noise pattern]} \\ \rightarrow 10\ 676\ 790 \end{array} \right\} \rightarrow \{3 \rightarrow 0.0738921, 4 \rightarrow 0.926108\},$

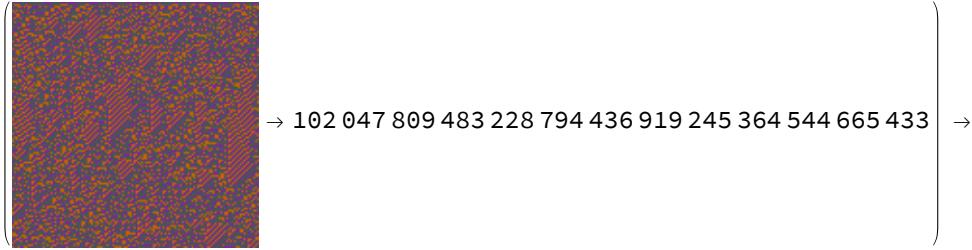
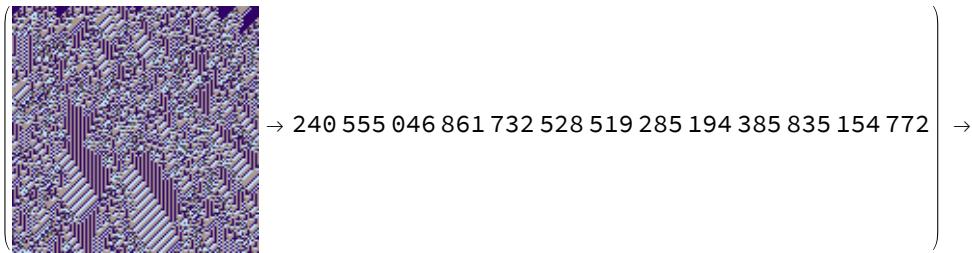
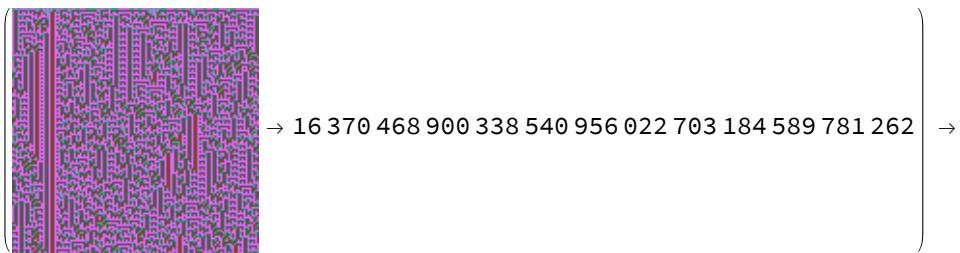
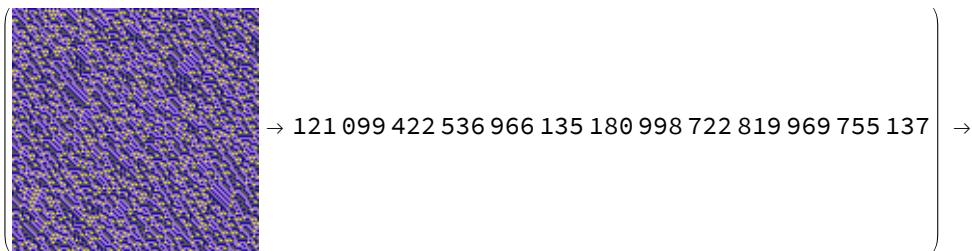
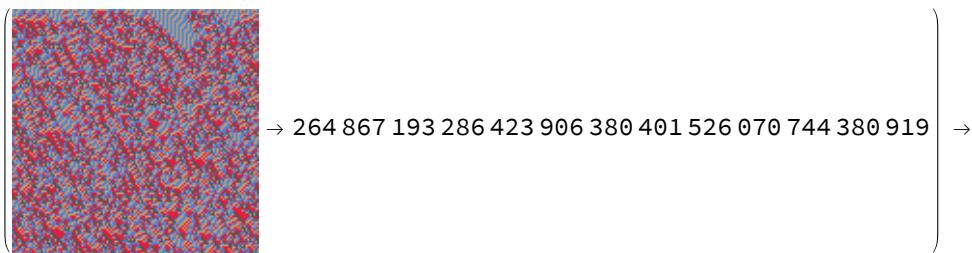
$\left\{ \begin{array}{c} \text{[A pink noise pattern]} \\ \rightarrow 10\ 375\ 449 \end{array} \right\} \rightarrow \{4 \rightarrow 1.04031 \times 10^{-17}, 3 \rightarrow 1.\},$



4-colour non-totalistic, range 1

```
In[]:= test4Data4kr1C17 = datak4r1NT[128, 128, 8];
Thread[
test4Data4kr1C17 → netECA17[Keys@test4Data4kr1C17, {"TopProbabilities", 2}]]
```



$\{4 \rightarrow 2.56385 \times 10^{-7}, 3 \rightarrow 1.\},$

 $\{4 \rightarrow 0.000696463, 3 \rightarrow 0.999304\},$

 $\{4 \rightarrow 3.62136 \times 10^{-16}, 3 \rightarrow 1.\},$

 $\{3 \rightarrow 1.45252 \times 10^{-15}, 4 \rightarrow 1.\},$

 $\{4 \rightarrow 0.0000270873, 3 \rightarrow 0.999973\},$

 $\{4 \rightarrow 0.105214, 3 \rightarrow 0.894786\}$

4-colour totalistic, range 2

```
In[]:= test4Data4kr2C17 = datak4r2C[128, 128, 8];
Thread[
  test4Data4kr2C17 → netECA17[Keys@test4Data4kr2C17, {"TopProbabilities", 2}]]
```

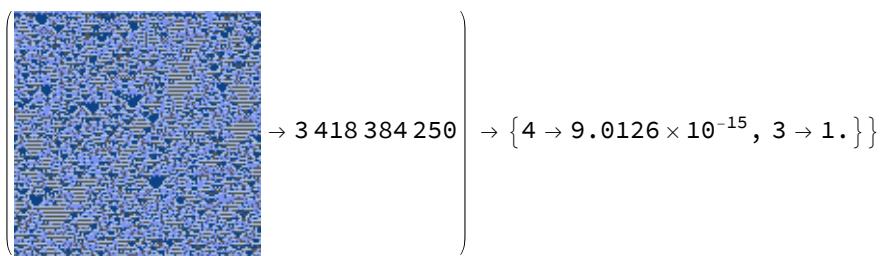
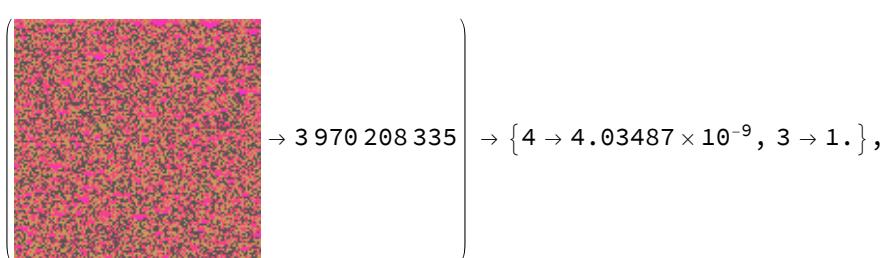
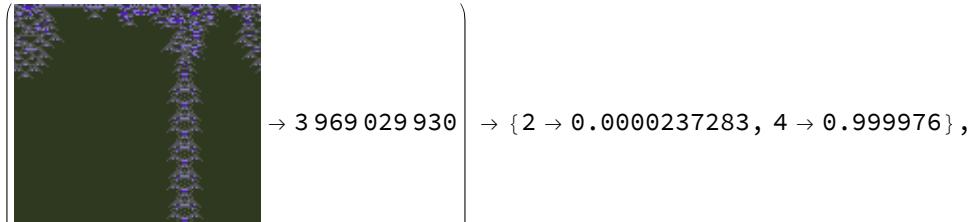
$$\text{Out}[]= \left\{ \begin{array}{l} \text{[A 128x128 grid of colored pixels]} \\ \rightarrow 616\ 082\ 315 \end{array} \right\} \rightarrow \{4 \rightarrow 8.8653 \times 10^{-10}, 3 \rightarrow 1.\},$$

$$\left\{ \begin{array}{l} \text{[A 128x128 grid of colored pixels]} \\ \rightarrow 1\ 568\ 191\ 428 \end{array} \right\} \rightarrow \{4 \rightarrow 5.21264 \times 10^{-11}, 3 \rightarrow 1.\},$$

$$\left\{ \begin{array}{l} \text{[A 128x128 grid of colored pixels]} \\ \rightarrow 1\ 216\ 110\ 065 \end{array} \right\} \rightarrow \{4 \rightarrow 0.000040346, 3 \rightarrow 0.99996\},$$

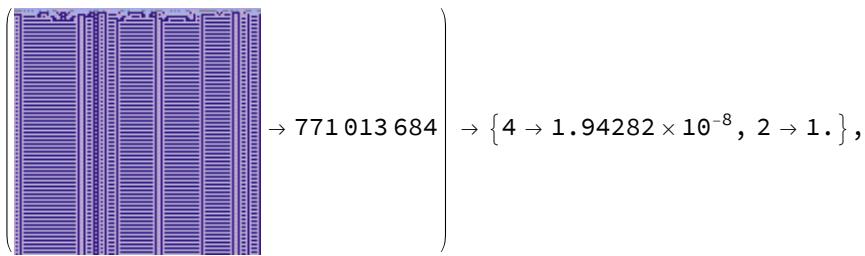
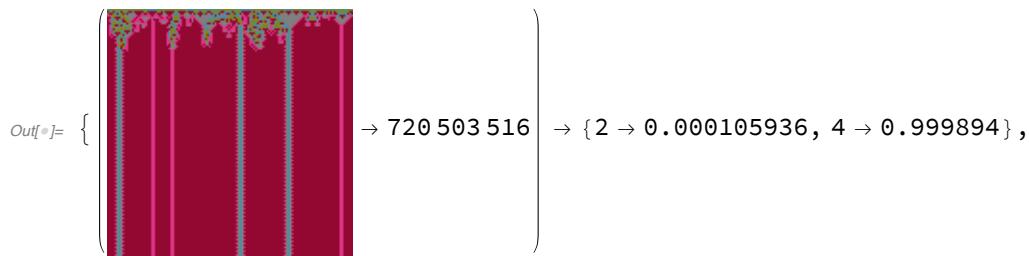
$$\left\{ \begin{array}{l} \text{[A 128x128 grid of colored pixels]} \\ \rightarrow 2\ 419\ 903\ 949 \end{array} \right\} \rightarrow \{4 \rightarrow 3.69897 \times 10^{-10}, 3 \rightarrow 1.\},$$

$$\left\{ \begin{array}{l} \text{[A 128x128 grid of colored pixels]} \\ \rightarrow 453\ 961\ 055 \end{array} \right\} \rightarrow \{4 \rightarrow 3.89961 \times 10^{-8}, 3 \rightarrow 1.\},$$



5-colour totalistic, range 1

```
In[]:= test4Data5kr1C17 = data5T2C[8, 128, 128];
Thread[
  test4Data5kr1C17 &gt; netECA17[Keys@test4Data5kr1C17, {"TopProbabilities", 2}]]
```



$$\left(\begin{array}{c} \text{[A 19x19 grid of random colors]} \\ \rightarrow 543\,872\,434 \end{array} \right) \rightarrow \{4 \rightarrow 6.11423 \times 10^{-7}, 3 \rightarrow 0.999999\},$$

$$\left(\begin{array}{c} \text{[A 19x19 grid of random colors]} \\ \rightarrow 341\,908\,586 \end{array} \right) \rightarrow \{4 \rightarrow 0.310854, 3 \rightarrow 0.689146\},$$

$$\left(\begin{array}{c} \text{[A 19x19 grid of random colors]} \\ \rightarrow 664\,036\,861 \end{array} \right) \rightarrow \{2 \rightarrow 0.00511847, 4 \rightarrow 0.994882\},$$

$$\left(\begin{array}{c} \text{[A 19x19 grid of random colors]} \\ \rightarrow 1\,182\,110\,899 \end{array} \right) \rightarrow \{4 \rightarrow 0.039023, 3 \rightarrow 0.960977\},$$

$$\left(\begin{array}{c} \text{[A 19x19 grid of random colors]} \\ \rightarrow 976\,082\,949 \end{array} \right) \rightarrow \{4 \rightarrow 9.09593 \times 10^{-19}, 2 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 19x19 grid of random colors]} \\ \rightarrow 1\,019\,517\,181 \end{array} \right) \rightarrow \{1 \rightarrow 6.47917 \times 10^{-10}, 2 \rightarrow 1.\}$$

6-colour totalistic, range 1

```
In[8]:= test4Data6kr1C17 = data6TC[8, 128, 128];
Thread[
  test4Data6kr1C17 → netECA17[Keys@test4Data6kr1C17, {"TopProbabilities", 2}]]
```

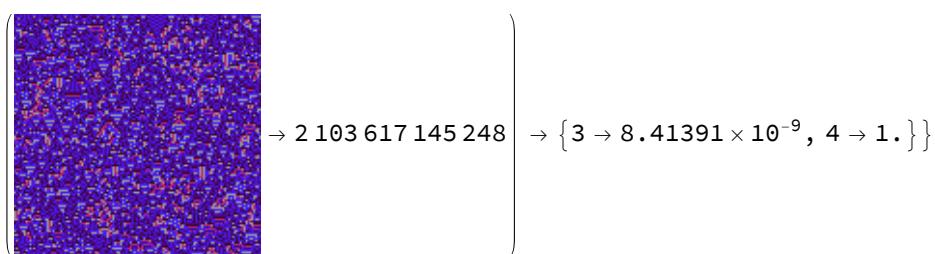
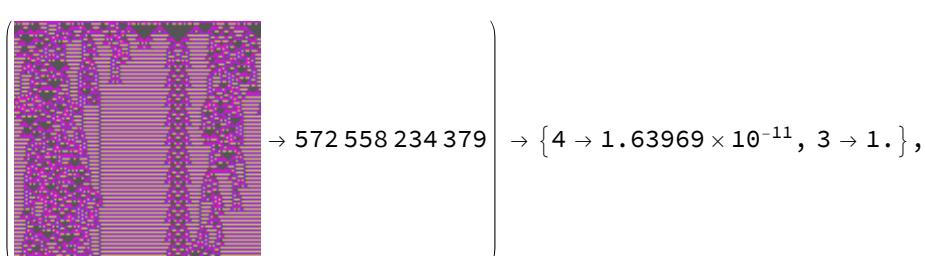
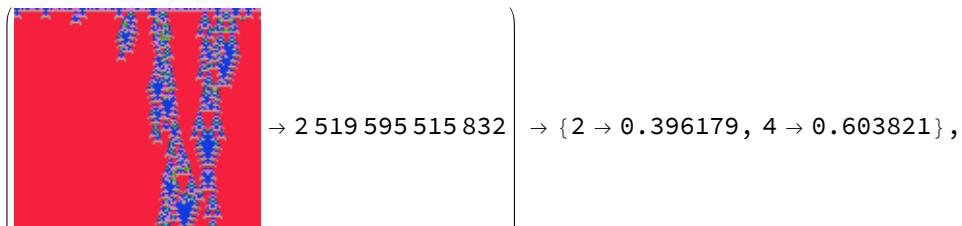
Out[8]= $\left\{ \begin{array}{c} \text{[A 128x128 grid of horizontal green and blue stripes]} \\ \rightarrow 1\ 128\ 957\ 409\ 115 \end{array} \right\} \rightarrow \{2 \rightarrow 0.387573, 1 \rightarrow 0.612427\},$

Out[8]= $\left\{ \begin{array}{c} \text{[A 128x128 grid of complex, multi-colored patterns]} \\ \rightarrow 744\ 151\ 919\ 694 \end{array} \right\} \rightarrow \{3 \rightarrow 1.28454 \times 10^{-11}, 4 \rightarrow 1.\},$

Out[8]= $\left\{ \begin{array}{c} \text{[A 128x128 grid of mostly red and green pixels]} \\ \rightarrow 411\ 482\ 269\ 593 \end{array} \right\} \rightarrow \{4 \rightarrow 9.50671 \times 10^{-6}, 3 \rightarrow 0.99999\},$

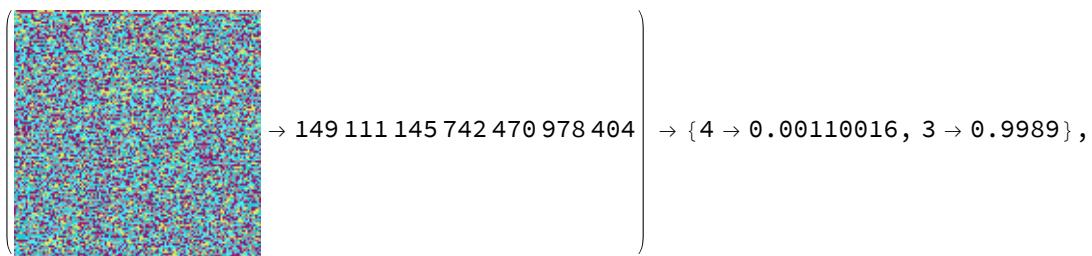
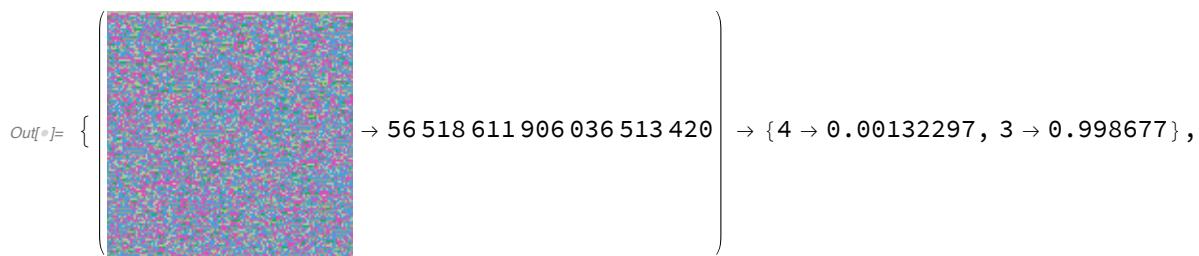
Out[8]= $\left\{ \begin{array}{c} \text{[A 128x128 grid of mostly blue and yellow pixels]} \\ \rightarrow 2\ 122\ 826\ 252\ 429 \end{array} \right\} \rightarrow \{4 \rightarrow 4.58698 \times 10^{-10}, 3 \rightarrow 1.\},$

Out[8]= $\left\{ \begin{array}{c} \text{[A 128x128 grid of mostly green and red pixels]} \\ \rightarrow 2\ 443\ 710\ 325\ 124 \end{array} \right\} \rightarrow \{4 \rightarrow 5.97811 \times 10^{-9}, 3 \rightarrow 1.\},$



6-colour totalistic, range 2

```
In[]:= test4Data6kr2C17 = data6T2C[8, 128, 128];
Thread[
  test4Data6kr2C17 → netECA17[Keys@test4Data6kr2C17, {"TopProbabilities", 2}]]
```



$$\left(\begin{array}{c} \text{[A 10x10 grid of blue and orange dots]} \\ \rightarrow 60\ 075\ 298\ 400\ 874\ 491\ 559 \end{array} \right) \rightarrow \{4 \rightarrow 0.0000816385, 3 \rightarrow 0.999918\},$$

$$\left(\begin{array}{c} \text{[A 10x10 grid of green and purple dots]} \\ \rightarrow 61\ 137\ 219\ 885\ 741\ 406\ 688 \end{array} \right) \rightarrow \{4 \rightarrow 6.01526 \times 10^{-9}, 3 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 10x10 grid of green and red dots]} \\ \rightarrow 138\ 083\ 937\ 800\ 052\ 503\ 915 \end{array} \right) \rightarrow \{4 \rightarrow 1.63338 \times 10^{-6}, 3 \rightarrow 0.999998\},$$

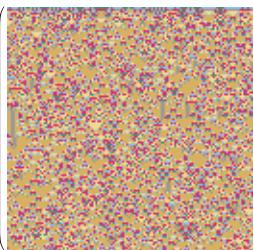
$$\left(\begin{array}{c} \text{[A 10x10 grid of red and yellow dots]} \\ \rightarrow 102\ 848\ 890\ 668\ 267\ 918\ 696 \end{array} \right) \rightarrow \{4 \rightarrow 4.51684 \times 10^{-8}, 3 \rightarrow 1.\},$$

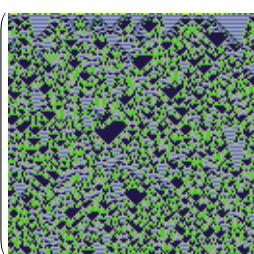
$$\left(\begin{array}{c} \text{[A 10x10 grid of blue and purple dots]} \\ \rightarrow 52\ 002\ 759\ 529\ 482\ 240\ 344 \end{array} \right) \rightarrow \{4 \rightarrow 0.0161382, 3 \rightarrow 0.983862\},$$

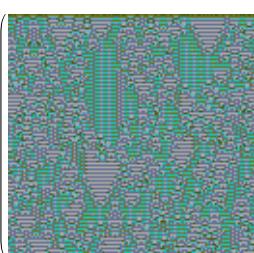
$$\left(\begin{array}{c} \text{[A 10x10 grid of green and pink dots]} \\ \rightarrow 3\ 771\ 326\ 190\ 903\ 203\ 597 \end{array} \right) \rightarrow \{4 \rightarrow 1.57635 \times 10^{-10}, 3 \rightarrow 1.\}\}$$

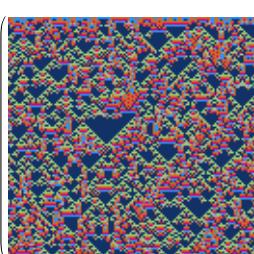
7-colour totalistic, range 1

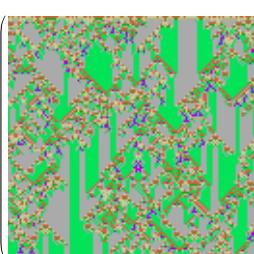
```
In[]:= test4Data7kr1C17 = data7TC[8, 128, 128];
Thread[
  test4Data7kr1C17 → netECA17[Keys@test4Data7kr1C17, {"TopProbabilities", 2}]]
```

$$\left. \left\{ \begin{array}{c} \text{Out}[1]= \left(\begin{array}{c} \text{test4Data7kr1C17} \\ \text{netECA17} \end{array} \right) \\ \rightarrow 249\,739\,897\,876\,317 \end{array} \right) \rightarrow \left\{ 4 \rightarrow 7.58753 \times 10^{-13}, 3 \rightarrow 1. \right\}, \right.$$


$$\left. \left\{ \begin{array}{c} \text{Out}[2]= \left(\begin{array}{c} \text{test4Data7kr1C17} \\ \text{netECA17} \end{array} \right) \\ \rightarrow 6\,589\,873\,174\,284\,234 \end{array} \right) \rightarrow \left\{ 4 \rightarrow 3.70203 \times 10^{-21}, 3 \rightarrow 1. \right\}, \right.$$


$$\left. \left\{ \begin{array}{c} \text{Out}[3]= \left(\begin{array}{c} \text{test4Data7kr1C17} \\ \text{netECA17} \end{array} \right) \\ \rightarrow 2\,838\,251\,451\,633\,386 \end{array} \right) \rightarrow \left\{ 3 \rightarrow 0.0000362001, 4 \rightarrow 0.999964 \right\}, \right.$$


$$\left. \left\{ \begin{array}{c} \text{Out}[4]= \left(\begin{array}{c} \text{test4Data7kr1C17} \\ \text{netECA17} \end{array} \right) \\ \rightarrow 3\,069\,021\,856\,393\,877 \end{array} \right) \rightarrow \left\{ 4 \rightarrow 4.6982 \times 10^{-6}, 3 \rightarrow 0.999995 \right\}, \right.$$


$$\left. \left\{ \begin{array}{c} \text{Out}[5]= \left(\begin{array}{c} \text{test4Data7kr1C17} \\ \text{netECA17} \end{array} \right) \\ \rightarrow 10\,282\,712\,720\,317\,214 \end{array} \right) \rightarrow \left\{ 3 \rightarrow 4.14045 \times 10^{-19}, 4 \rightarrow 1. \right\}, \right.$$


$$\left(\begin{array}{c} \text{[A 128x128 grid of random colors]} \\ \rightarrow 203\ 015\ 413\ 423\ 084 \end{array} \right) \rightarrow \{ 4 \rightarrow 2.87431 \times 10^{-9}, 3 \rightarrow 1. \},$$

$$\left(\begin{array}{c} \text{[A 128x128 grid of random colors with green highlights]} \\ \rightarrow 9\ 746\ 864\ 148\ 555\ 591 \end{array} \right) \rightarrow \{ 3 \rightarrow 1.53822 \times 10^{-7}, 4 \rightarrow 1. \},$$

$$\left(\begin{array}{c} \text{[A 128x128 grid of random colors with purple highlights]} \\ \rightarrow 8\ 003\ 062\ 538\ 664\ 128 \end{array} \right) \rightarrow \{ 3 \rightarrow 2.05185 \times 10^{-8}, 4 \rightarrow 1. \}$$

8-colour totalistic, range 1

```
In[]:= test4Data8kr1C17 = data8TC[8, 128, 128];
Thread[
  test4Data8kr1C17 &gt; netECA17[Keys@test4Data8kr1C17, {"TopProbabilities", 2}]]
```

$$\text{Out}[=] = \left(\begin{array}{c} \text{[A 128x128 grid of random colors]} \\ \rightarrow 10\ 266\ 196\ 594\ 935\ 096\ 075 \end{array} \right) \rightarrow \{ 4 \rightarrow 8.5791 \times 10^{-18}, 3 \rightarrow 1. \},$$

$$\left(\begin{array}{c} \text{[A 128x128 grid of random colors]} \\ \rightarrow 731\ 338\ 973\ 990\ 773\ 560 \end{array} \right) \rightarrow \{ 2 \rightarrow 7.53019 \times 10^{-12}, 4 \rightarrow 1. \},$$

$$\left(\begin{array}{c} \text{[A 2x2 grid of random colors]} \\ \rightarrow 11\ 247\ 173\ 012\ 174\ 218\ 620 \end{array} \right) \rightarrow \{4 \rightarrow 0.0000380778, 3 \rightarrow 0.999962\},$$

$$\left(\begin{array}{c} \text{[A 2x2 grid of random colors]} \\ \rightarrow 63\ 742\ 472\ 032\ 617\ 219\ 918 \end{array} \right) \rightarrow \{4 \rightarrow 0.0000371126, 3 \rightarrow 0.999963\},$$

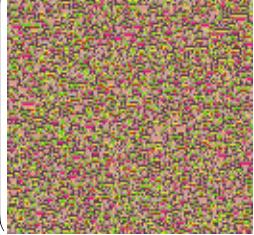
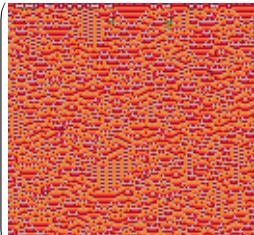
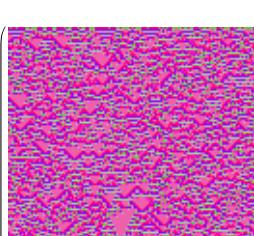
$$\left(\begin{array}{c} \text{[A 2x2 grid of random colors]} \\ \rightarrow 7\ 382\ 455\ 380\ 800\ 363\ 015 \end{array} \right) \rightarrow \{4 \rightarrow 8.07468 \times 10^{-15}, 3 \rightarrow 1.\},$$

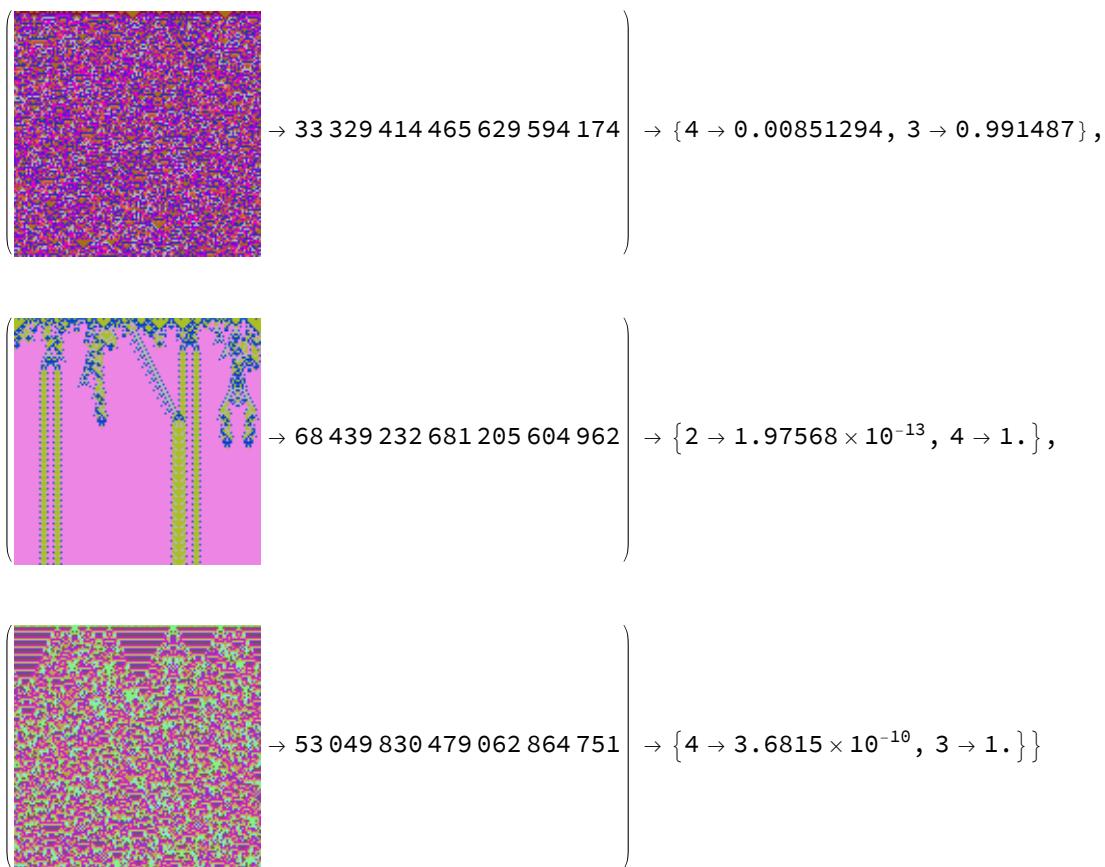
$$\left(\begin{array}{c} \text{[A 2x2 grid of random colors]} \\ \rightarrow 59\ 100\ 651\ 667\ 569\ 734\ 000 \end{array} \right) \rightarrow \{4 \rightarrow 1.27228 \times 10^{-11}, 3 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 2x2 grid of random colors]} \\ \rightarrow 24\ 971\ 306\ 247\ 396\ 766\ 335 \end{array} \right) \rightarrow \{4 \rightarrow 0.0333734, 3 \rightarrow 0.966627\},$$

$$\left(\begin{array}{c} \text{[A 2x2 grid of random colors]} \\ \rightarrow 45\ 946\ 581\ 080\ 593\ 555\ 746 \end{array} \right) \rightarrow \{4 \rightarrow 1.08598 \times 10^{-15}, 3 \rightarrow 1.\}\}$$

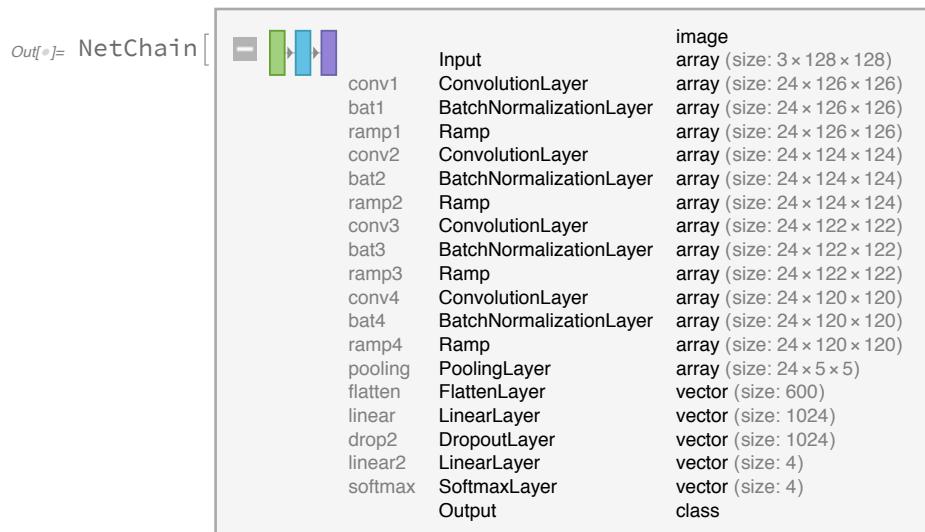
```
In[8]:= test4Data8kr1C17 = data8TC[8, 128, 128];
Thread[
  test4Data8kr1C17 → netECA17[Keys@test4Data8kr1C17, {"TopProbabilities", 2}]]
```

Out[8]= { → 14 955 350 598 586 141 683,  → 30 727 455 169 449 395 964,  → 42 490 152 676 883 207 115,  → 18 395 296 261 071 222 192,  → 22 317 090 484 634 250 431}

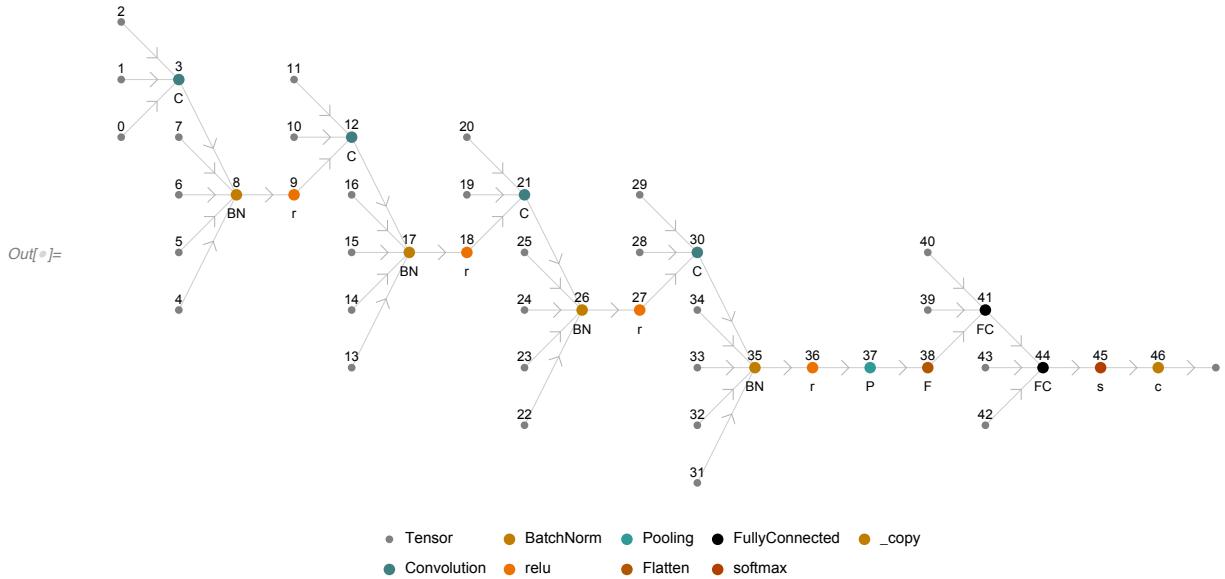


Network XVIII- Four convolutions, dropout on linear only, BatchNorm

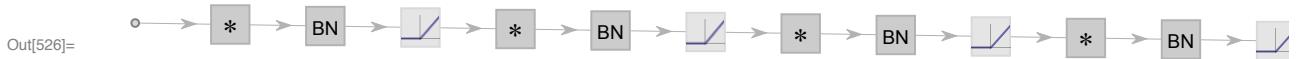
```
In[6]:= netECA18 = netTenCC1024drop[128, 128]
```



```
In[8]:= NetInformation[netECA18, "MXNetNodeGraphPlot"]
```



```
In[526]:= NetInformation[netECA18, "SummaryGraphic"]
```



```
In[8]:= dataECA18 = dataC[128, 128, 16 384];
```

```
In[8]:= dataTotalistic2BigC18 = genData2r2C[128, 128, 4096];
```

```
In[8]:= dataTotalistic3BigC18 = data3T2C[128, 128, 4096];
```

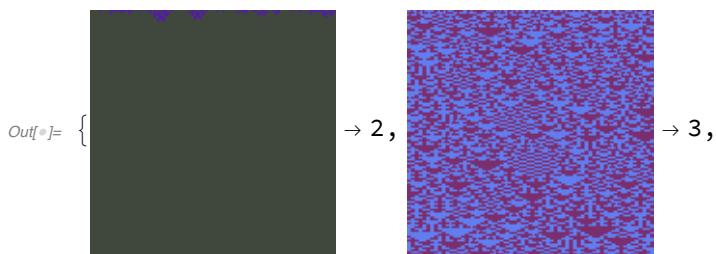
```
In[8]:= dataTotalistic4BigC18 = data4TC[128, 128, 4096];
```

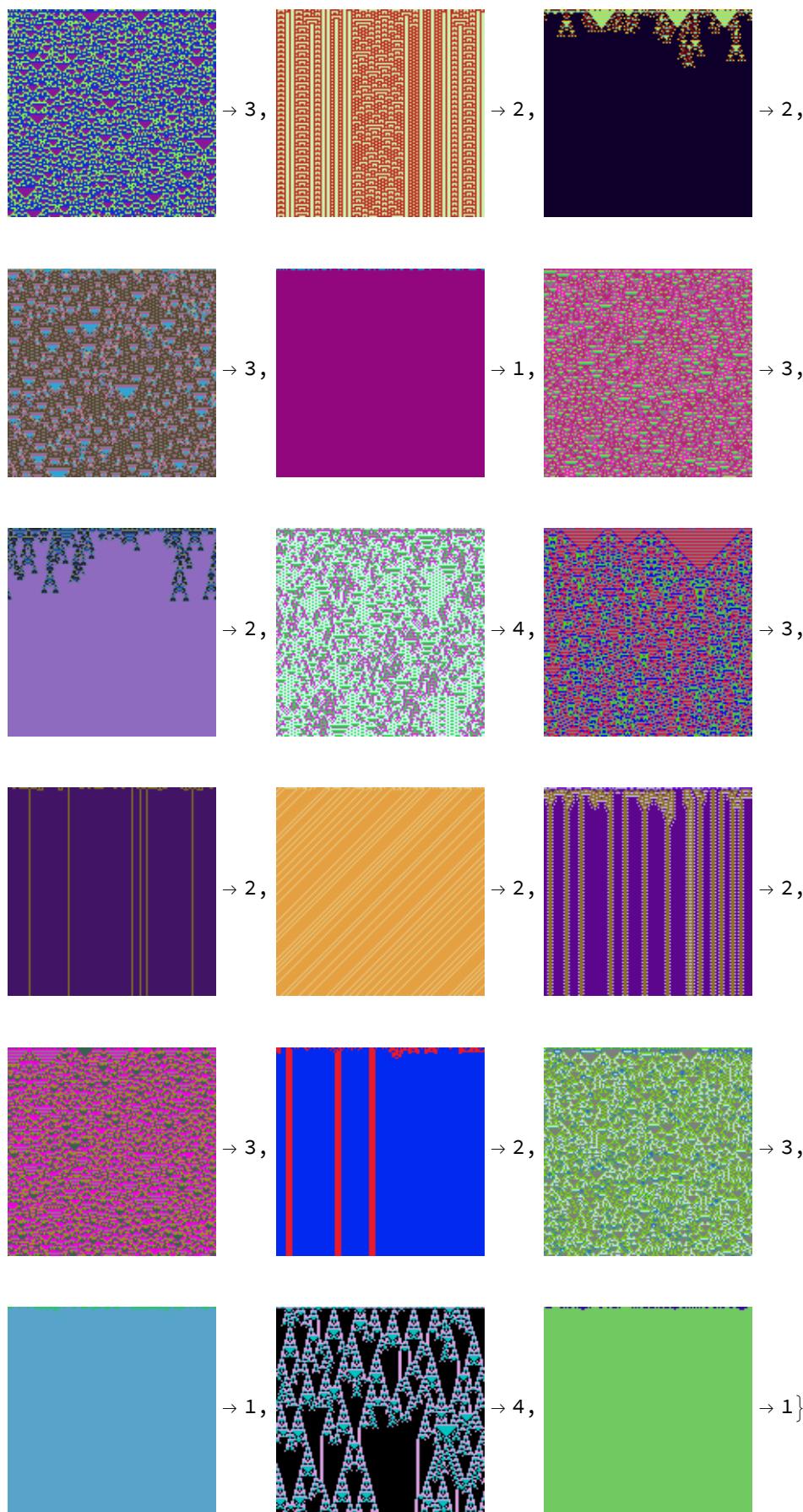
```
In[8]:= dataTotalistic5BigC18 = genData5TCC[128, 128, 16 384];
```

```
In[8]:= fullTrainingBigC18 = Join[dataECA18, dataTotalistic2BigC18,
    dataTotalistic3BigC18, dataTotalistic4BigC18, dataTotalistic5BigC18];
Length[fullTrainingBigC18]
```

```
Out[8]= 90 112
```

```
In[8]:= RandomSample[fullTrainingBigC18, 20]
```





```
In[1]:= dir = SetDirectory[NotebookDirectory[]]
Out[1]= /home/esilverman/Documents

In[2]:= "/home/esilverman/Documents"
Out[2]= /home/esilverman/Documents

In[3]:= netECA18 = NetTrain[netECA18, fullTrainingBigC18,
  MaxTrainingRounds → 200, BatchSize → 256, TargetDevice → "GPU",
  TrainingProgressCheckpointing → {"Directory", dir}]
```

Out[3]= NetChain[ Input port: image
Output port: class
Number of layers: 18]

```
In[4]:= netECA18 = Import["netECA18-r200.wlnet"]
```

Out[4]= NetChain[ Input port: image
Output port: class
Number of layers: 18]

Generate test data for Network XVII (200 epochs)

```
In[5]:= dir = SetDirectory[NotebookDirectory[]]
Out[5]= /Users/thorsilver/Downloads/Wolfram notebooks
```

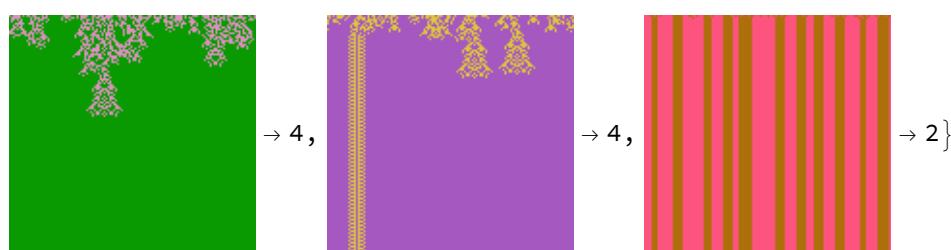
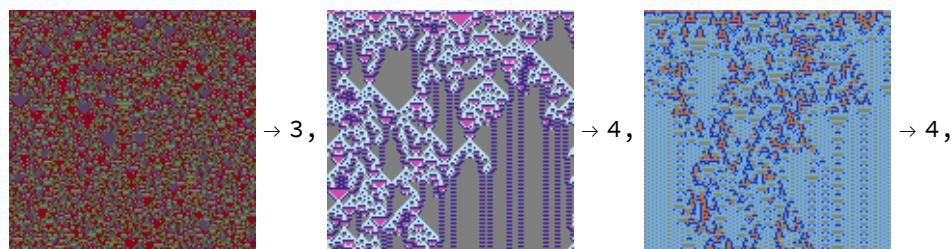
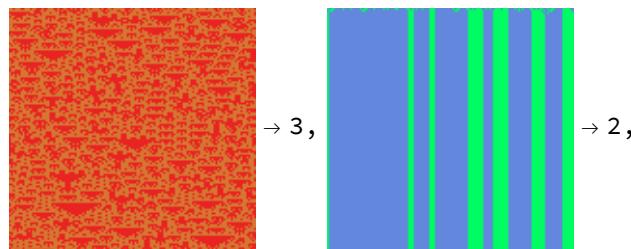
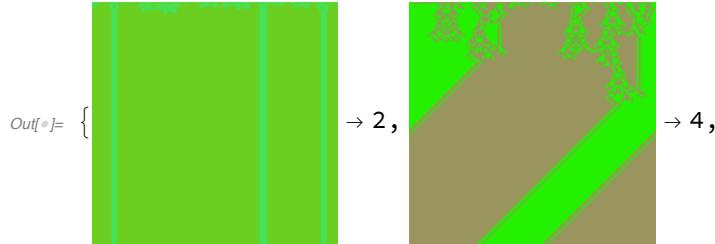
```
In[180]:= netECA18 = Import["netECA18-r200.wlnet"]
```

Out[180]= NetChain[ Input image
conv1 ConvolutionLayer array (size: 3 × 128 × 128)
bat1 BatchNormalizationLayer array (size: 24 × 126 × 126)
ramp1 Ramp array (size: 24 × 126 × 126)
conv2 ConvolutionLayer array (size: 24 × 124 × 124)
bat2 BatchNormalizationLayer array (size: 24 × 124 × 124)
ramp2 Ramp array (size: 24 × 124 × 124)
conv3 ConvolutionLayer array (size: 24 × 122 × 122)
bat3 BatchNormalizationLayer array (size: 24 × 122 × 122)
ramp3 Ramp array (size: 24 × 122 × 122)
conv4 ConvolutionLayer array (size: 24 × 120 × 120)
bat4 BatchNormalizationLayer array (size: 24 × 120 × 120)
ramp4 Ramp array (size: 24 × 120 × 120)
pooling PoolingLayer array (size: 24 × 5 × 5)
flatten FlattenLayer vector (size: 600)
linear LinearLayer vector (size: 1024)
drop2 DropoutLayer vector (size: 1024)
linear2 LinearLayer vector (size: 4)
softmax SoftmaxLayer vector (size: 4)
Output class]

```
In[®]:= testDataECABigC = dataC[128, 128, 1024];
testData2TBigC = genData2r2C[128, 128, 1024];
testData3TBigC = data3T2C[128, 128, 1024];
testData4TBigC = data4TC[128, 128, 1024];
testData5TBigC = genData5TCC[128, 128, 1024];
fullTestSetBigC = Join[testDataECABigC,
  testData2TBigC, testData3TBigC, testData4TBigC, testData5TBigC];
Length[fullTestSetBigC]
```

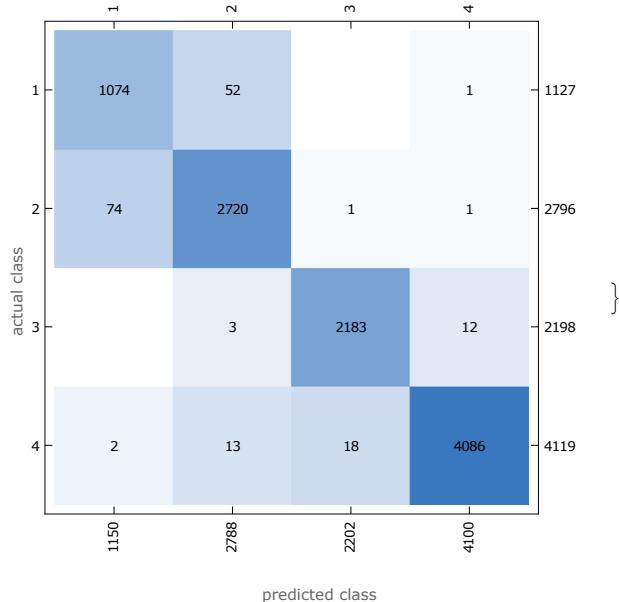
Out[®]= 10240

```
In[®]:= RandomSample[fullTestSetBigC, 10]
```

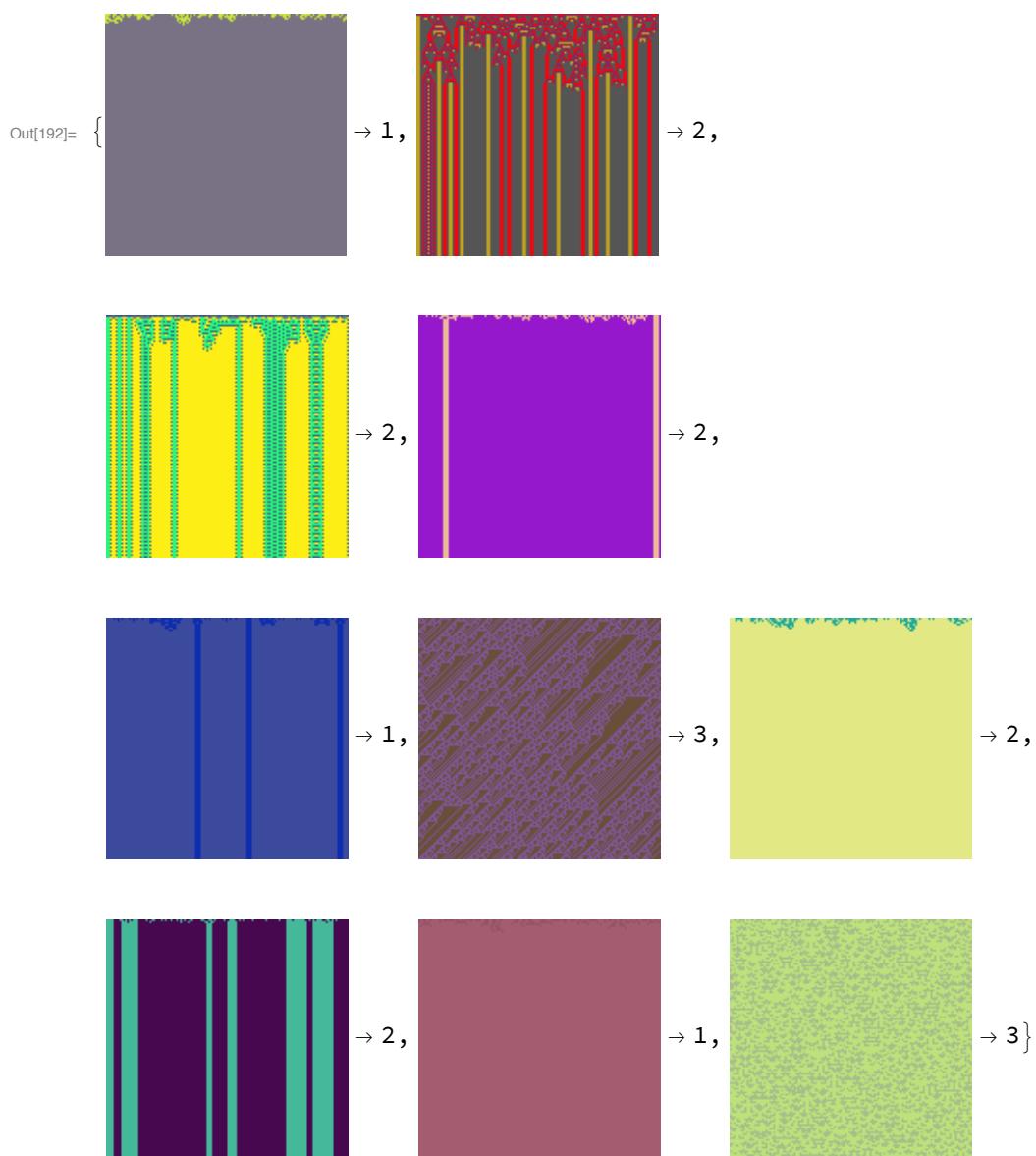


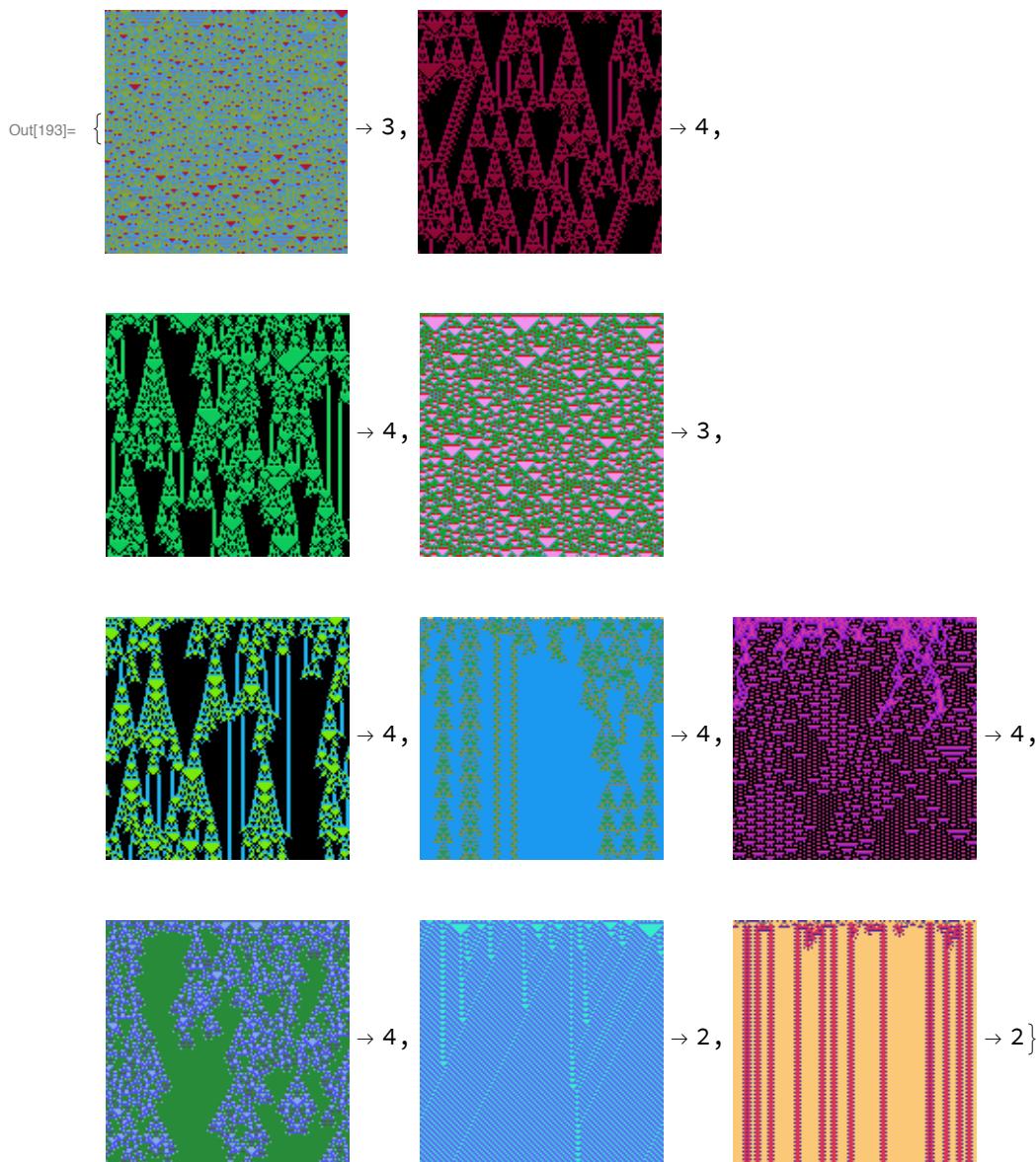
```
In[181]:= NetMeasurements[netECA18, fullTestSetBigC,
 {"Accuracy", "Precision", "ConfusionMatrixPlot"}]

Out[181]= {0.982715, {1 → 0.933913, 2 → 0.97561, 3 → 0.991371, 4 → 0.996585}, }
```



```
In[188]:= entropyImagesBigC = RandomSample[Keys[fullTestSetBigC], 500];
entropiesBigC = netECA18[entropyImagesBigC, "Entropy"];
highEntBigC = entropyImagesBigC[[Ordering[entropiesBigC, -10]]];
lowEntBigC = entropyImagesBigC[[Ordering[entropiesBigC, 10]]];
Thread[highEntBigC → netECA18[highEntBigC]]
Thread[lowEntBigC → netECA18[lowEntBigC]]
```





Testing Network XVIII (200 epochs) on unseen CA rule spaces

2-colour non-totalistic, range 2

```
In[527]:= test4Data2kr2C18 = datak2r2C[128, 128, 8];
Thread[
  test4Data2kr2C18 → netECA18[Keys@test4Data2kr2C18, {"TopProbabilities", 2}]]
```

Out[528]= {

$\rightarrow 1\ 370\ 260\ 644 \rightarrow \{4 \rightarrow 0.0166854, 2 \rightarrow 0.983315\},$

$$\left(\begin{array}{c} \text{[A 1807 990 148]} \\ \rightarrow 1807990148 \end{array} \right) \rightarrow \{2 \rightarrow 3.85446 \times 10^{-17}, 3 \rightarrow 1.\},$$

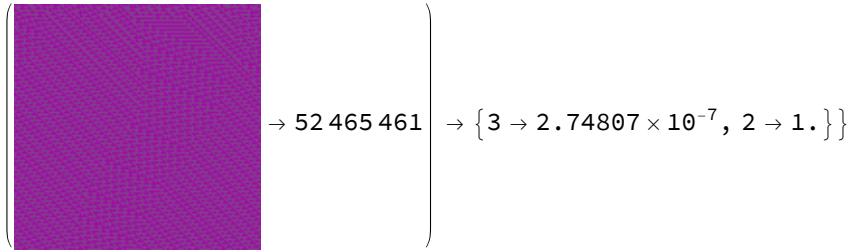
$$\left(\begin{array}{c} \text{[A 2 530 190 276]} \\ \rightarrow 2530190276 \end{array} \right) \rightarrow \{4 \rightarrow 2.53726 \times 10^{-6}, 3 \rightarrow 0.999997\},$$

$$\left(\begin{array}{c} \text{[A 2 788 659 278]} \\ \rightarrow 2788659278 \end{array} \right) \rightarrow \{4 \rightarrow 7.89003 \times 10^{-11}, 3 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 1 183 464 169]} \\ \rightarrow 1183464169 \end{array} \right) \rightarrow \{4 \rightarrow 8.12001 \times 10^{-9}, 3 \rightarrow 1.\},$$

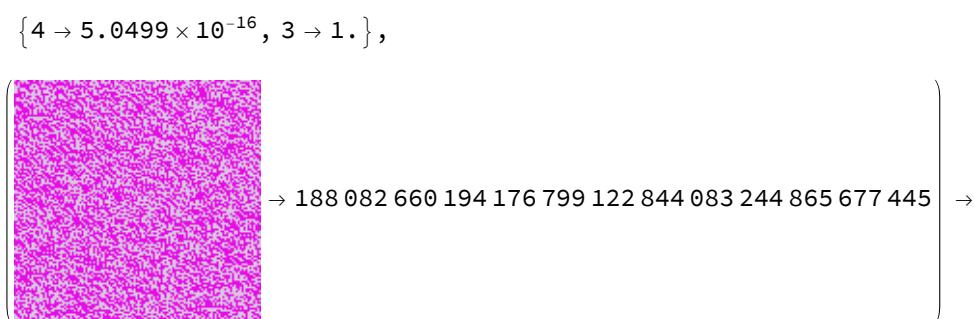
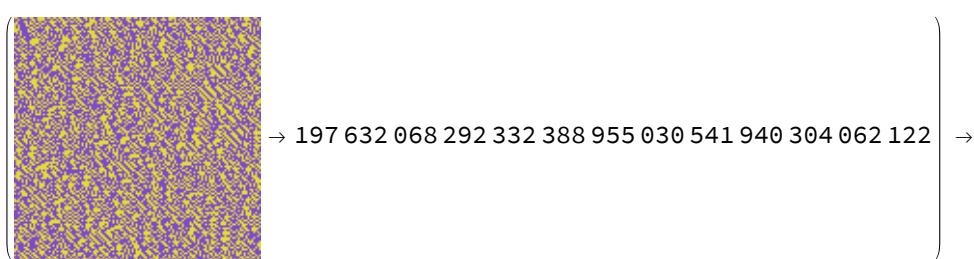
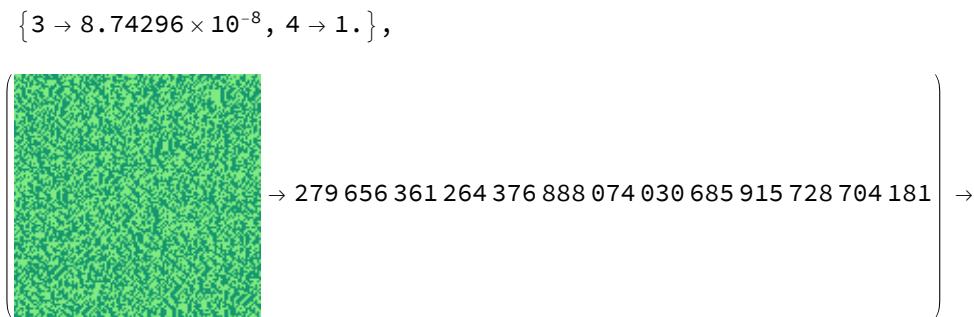
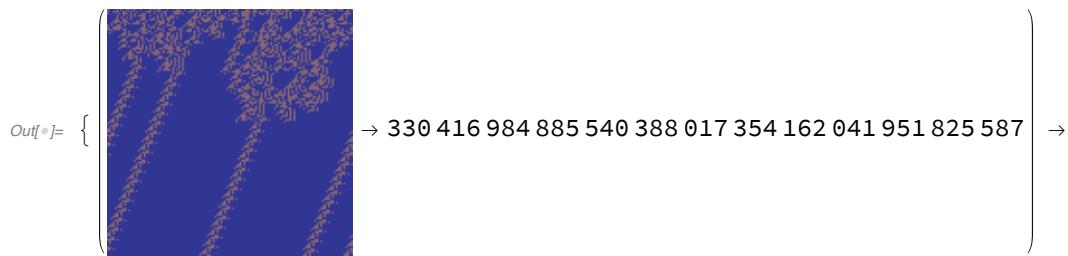
$$\left(\begin{array}{c} \text{[A 3 203 768 679]} \\ \rightarrow 3203768679 \end{array} \right) \rightarrow \{4 \rightarrow 1.44395 \times 10^{-7}, 3 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 1 424 091 569]} \\ \rightarrow 1424091569 \end{array} \right) \rightarrow \{2 \rightarrow 2.16345 \times 10^{-7}, 4 \rightarrow 1.\},$$

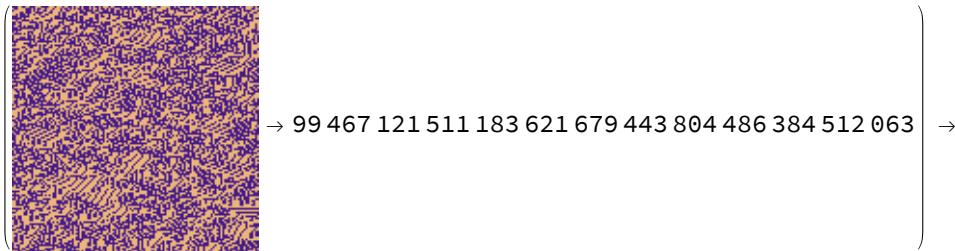


2-colour non-totalistic, range 3

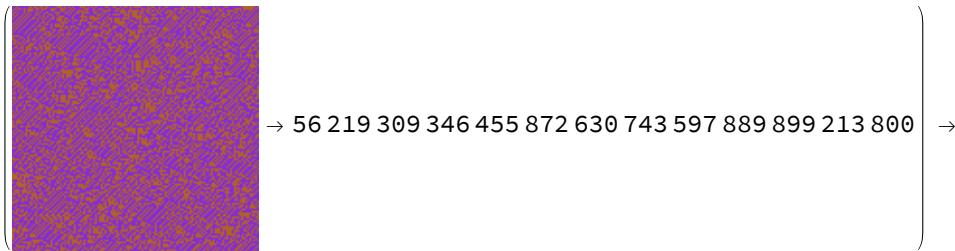
```
In[6]:= test4Data2kr3C18 = datak2r3NT[128, 128, 8];
Thread[
test4Data2kr3C18 → netECA18[Keys@test4Data2kr3C18, {"TopProbabilities", 2}]]
```



$\{4 \rightarrow 2.34238 \times 10^{-6}, 3 \rightarrow 0.999998\},$



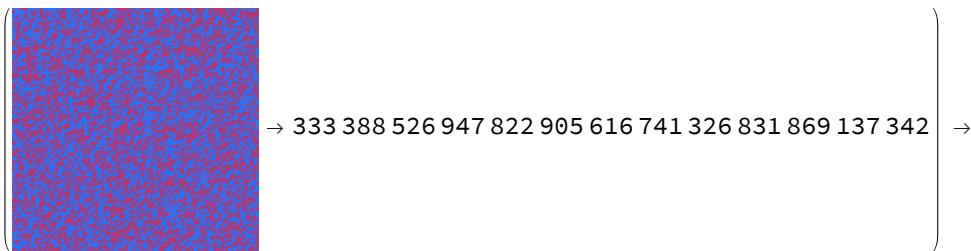
$\{4 \rightarrow 0.00329566, 3 \rightarrow 0.996704\},$



$\{4 \rightarrow 1.38574 \times 10^{-10}, 3 \rightarrow 1.\},$



$\{4 \rightarrow 5.1263 \times 10^{-8}, 3 \rightarrow 1.\},$



$\{4 \rightarrow 7.10494 \times 10^{-8}, 3 \rightarrow 1.\}\}$

3-colour non-totalistic, range 1

```
In[6]:= test4Data3kr1C18 = datak3r1NT[128, 128, 8];
Thread[
test4Data3kr1C18 → netECA18[Keys@test4Data3kr1C18, {"TopProbabilities", 2}]]
```

$$Out[1]= \left\{ \begin{array}{l} \text{(A 2x2 grid of yellow dots)} \\ \rightarrow 1\ 592\ 394\ 332\ 064 \end{array} \right\} \rightarrow \{2 \rightarrow 7.59314 \times 10^{-6}, 4 \rightarrow 0.999992\},$$

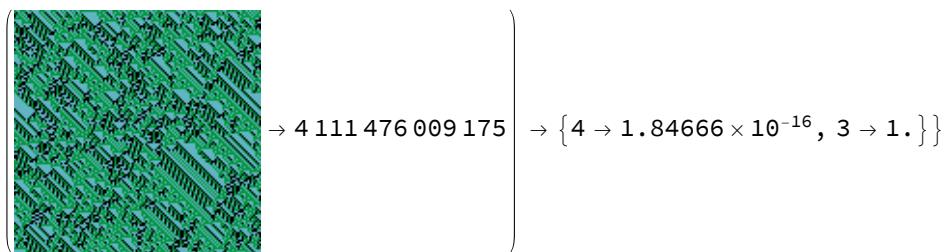
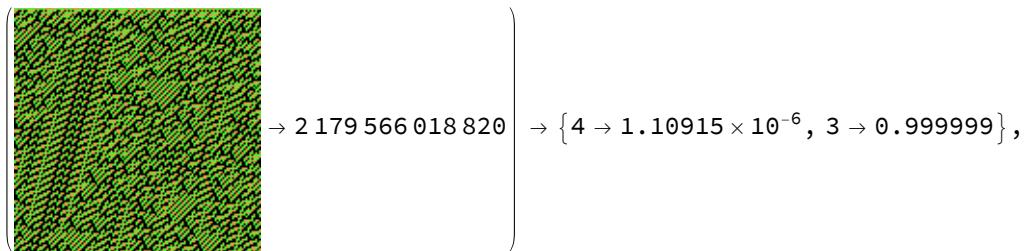
$$\left\{ \begin{array}{l} \text{(A 2x2 grid of purple dots)} \\ \rightarrow 4\ 098\ 174\ 485\ 356 \end{array} \right\} \rightarrow \{4 \rightarrow 8.44302 \times 10^{-20}, 2 \rightarrow 1.\},$$

$$\left\{ \begin{array}{l} \text{(A 2x2 grid of blue dots)} \\ \rightarrow 5\ 930\ 373\ 291\ 731 \end{array} \right\} \rightarrow \{1 \rightarrow 2.34989 \times 10^{-7}, 2 \rightarrow 1.\},$$

$$\left\{ \begin{array}{l} \text{(A 2x2 grid of green dots)} \\ \rightarrow 6\ 363\ 744\ 081\ 807 \end{array} \right\} \rightarrow \{3 \rightarrow 0.0000390704, 4 \rightarrow 0.999961\},$$

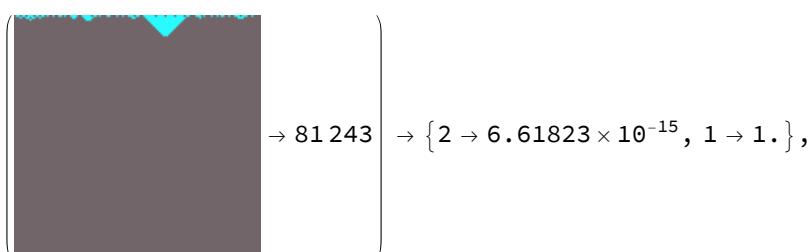
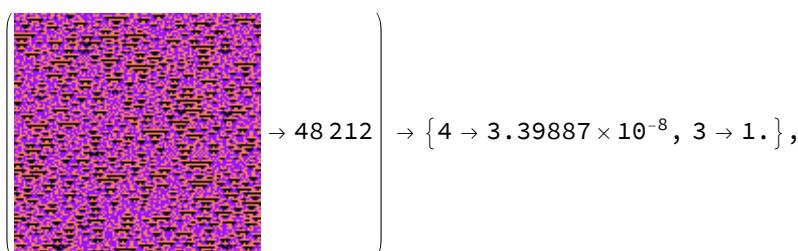
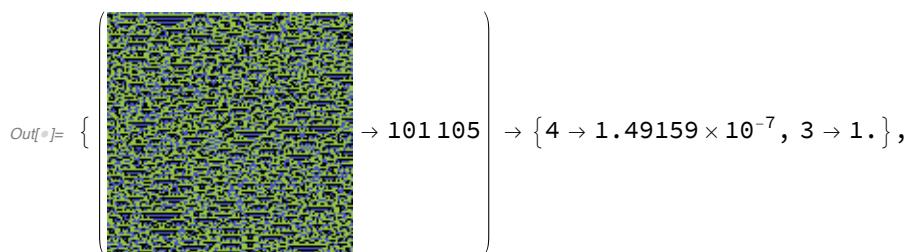
$$\left\{ \begin{array}{l} \text{(A 2x2 grid of yellow and blue dots)} \\ \rightarrow 1\ 193\ 083\ 886\ 293 \end{array} \right\} \rightarrow \{4 \rightarrow 0.0126455, 3 \rightarrow 0.987355\},$$

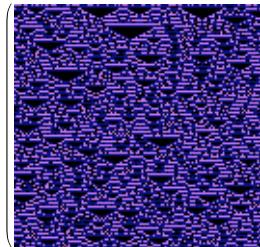
$$\left\{ \begin{array}{l} \text{(A 2x2 grid of green and blue dots)} \\ \rightarrow 1\ 957\ 822\ 902\ 340 \end{array} \right\} \rightarrow \{3 \rightarrow 0.0000561806, 2 \rightarrow 0.999944\},$$

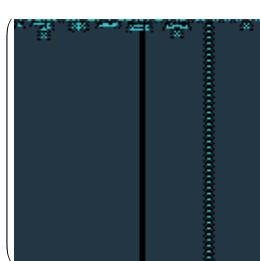


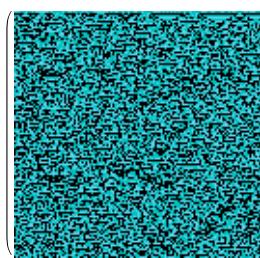
3-colour totalistic, range 2

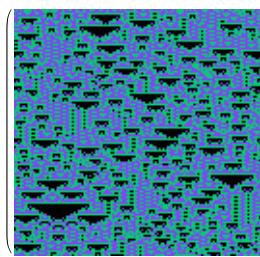
```
In[]:= test4Data3kr2C18 = datak3r2C[128, 128, 8];
Thread[
  test4Data3kr2C18 → netECA18[Keys@test4Data3kr2C18, {"TopProbabilities", 2}]]
```

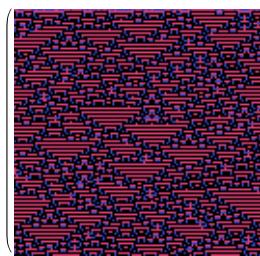


 $\rightarrow 144\ 952 \left. \right\} \rightarrow \{ 4 \rightarrow 5.58692 \times 10^{-14}, 3 \rightarrow 1. \},$

 $\rightarrow 167\ 730 \left. \right\} \rightarrow \{ 1 \rightarrow 3.79715 \times 10^{-7}, 2 \rightarrow 1. \},$

 $\rightarrow 102\ 220 \left. \right\} \rightarrow \{ 4 \rightarrow 3.5215 \times 10^{-7}, 3 \rightarrow 1. \},$

 $\rightarrow 129\ 071 \left. \right\} \rightarrow \{ 4 \rightarrow 5.28522 \times 10^{-29}, 3 \rightarrow 1. \},$

 $\rightarrow 94\ 027 \left. \right\} \rightarrow \{ 4 \rightarrow 3.95426 \times 10^{-7}, 3 \rightarrow 1. \}$

3-colour totalistic, range 3

```
In[⑩]:= test4Data3kr3C18 = datak3r3C[128, 128, 8];
Thread[
test4Data3kr3C18 → netECA18[Keys@test4Data3kr3C18, {"TopProbabilities", 2}]]
```

Out[•]= $\left\{ \begin{array}{l} \text{[A 10x10 grid of blue and yellow pixels]} \\ \rightarrow 461960 \end{array} \right\} \rightarrow \{4 \rightarrow 4.84455 \times 10^{-6}, 3 \rightarrow 0.999995\},$

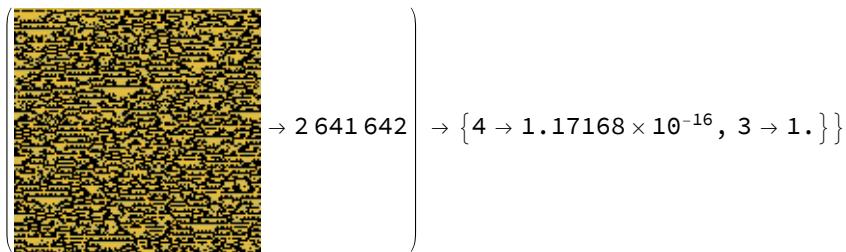
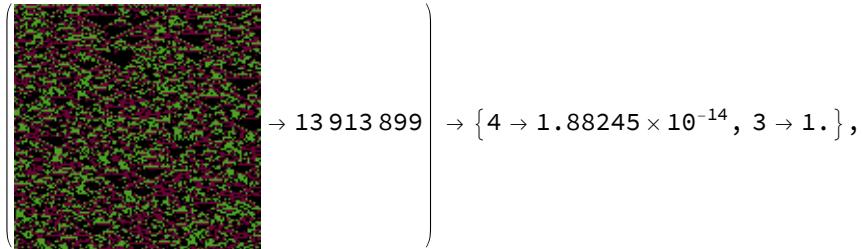
$\left\{ \begin{array}{l} \text{[A 10x10 grid of blue and brown pixels]} \\ \rightarrow 4823863 \end{array} \right\} \rightarrow \{4 \rightarrow 1.80913 \times 10^{-22}, 3 \rightarrow 1.\},$

$\left\{ \begin{array}{l} \text{[A 10x10 grid of green and black pixels]} \\ \rightarrow 7272180 \end{array} \right\} \rightarrow \{3 \rightarrow 3.43734 \times 10^{-9}, 4 \rightarrow 1.\},$

$\left\{ \begin{array}{l} \text{[A 10x10 grid of blue and yellow pixels]} \\ \rightarrow 8672980 \end{array} \right\} \rightarrow \{4 \rightarrow 6.70981 \times 10^{-6}, 3 \rightarrow 0.999993\},$

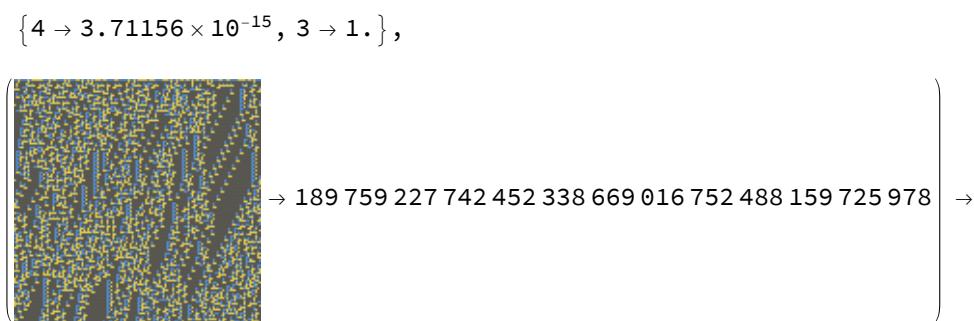
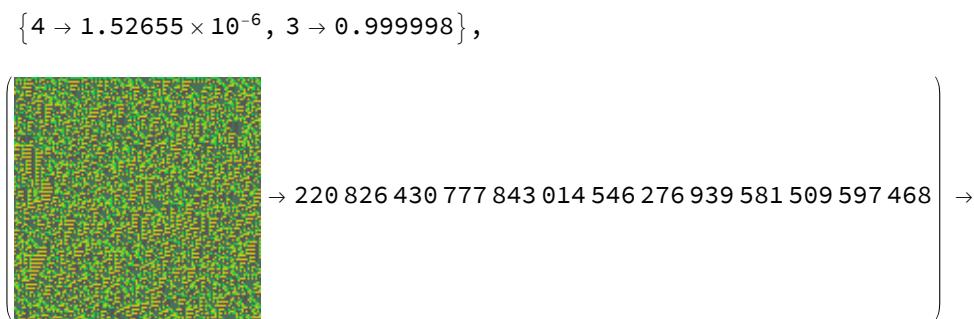
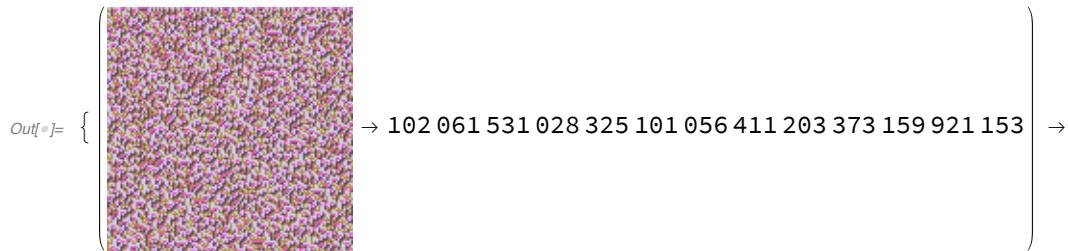
$\left\{ \begin{array}{l} \text{[A 10x10 grid of pink and black pixels]} \\ \rightarrow 254357 \end{array} \right\} \rightarrow \{4 \rightarrow 2.17773 \times 10^{-6}, 3 \rightarrow 0.999998\},$

$\left\{ \begin{array}{l} \text{[A 10x10 grid of green and black pixels]} \\ \rightarrow 9226537 \end{array} \right\} \rightarrow \{4 \rightarrow 1.70317 \times 10^{-12}, 3 \rightarrow 1.\},$

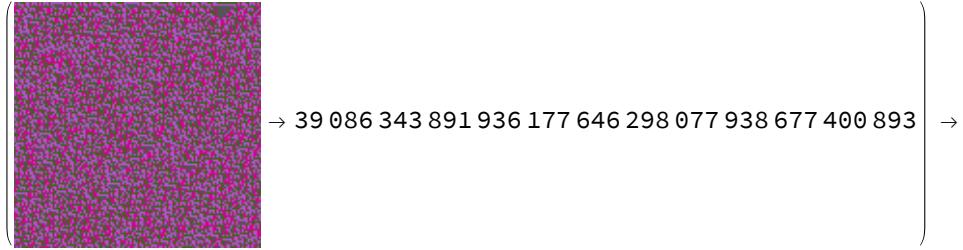


4-colour non-totalistic, range 1

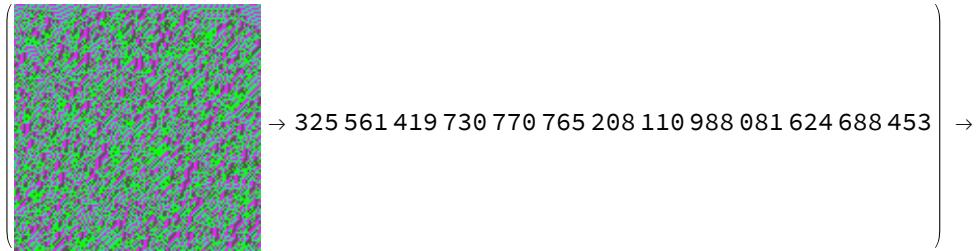
```
In[]:= test4Data4kr1C18 = datak4r1NT[128, 128, 8];
Thread[
  test4Data4kr1C18 → netECA18[Keys@test4Data4kr1C18, {"TopProbabilities", 2}]]
```



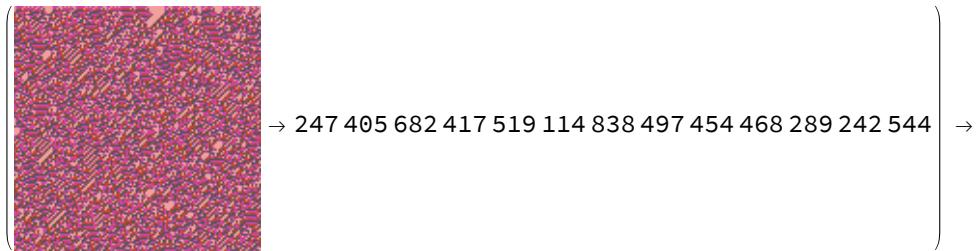
$$\{3 \rightarrow 1.71606 \times 10^{-19}, 4 \rightarrow 1.\},$$



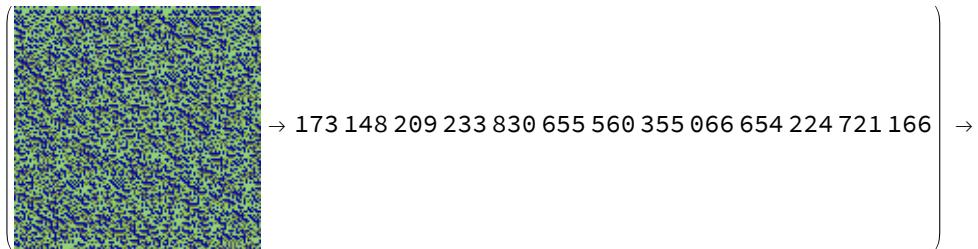
$$\{4 \rightarrow 0.0000617923, 3 \rightarrow 0.999938\},$$



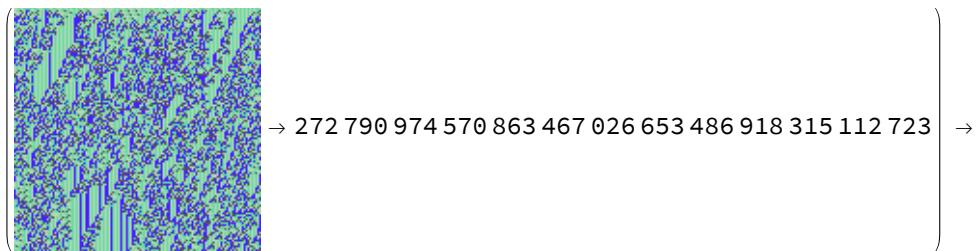
$$\{4 \rightarrow 4.25321 \times 10^{-7}, 3 \rightarrow 1.\},$$



$$\{4 \rightarrow 3.94091 \times 10^{-12}, 3 \rightarrow 1.\},$$



$$\{4 \rightarrow 1.19081 \times 10^{-14}, 3 \rightarrow 1.\},$$



$$\{3 \rightarrow 2.26679 \times 10^{-10}, 4 \rightarrow 1.\}$$

4-colour totalistic, range 2

```
In[]:= test4Data4kr2C18 = datak4r2C[128, 128, 8];
Thread[
  test4Data4kr2C18 → netECA18[Keys@test4Data4kr2C18, {"TopProbabilities", 2}]]
```

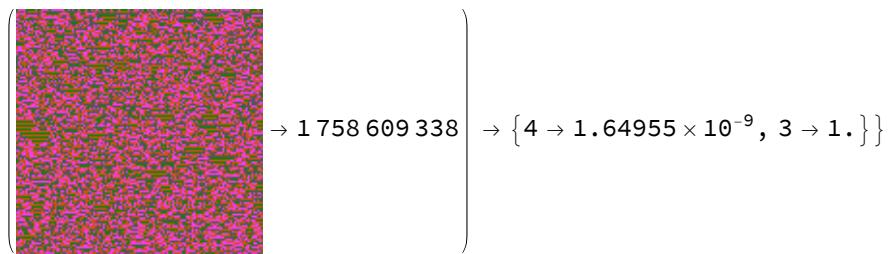
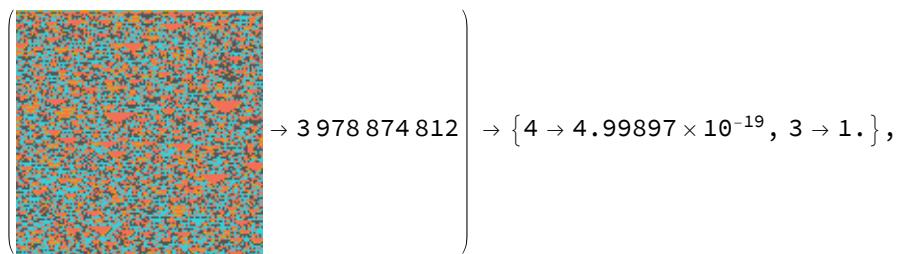
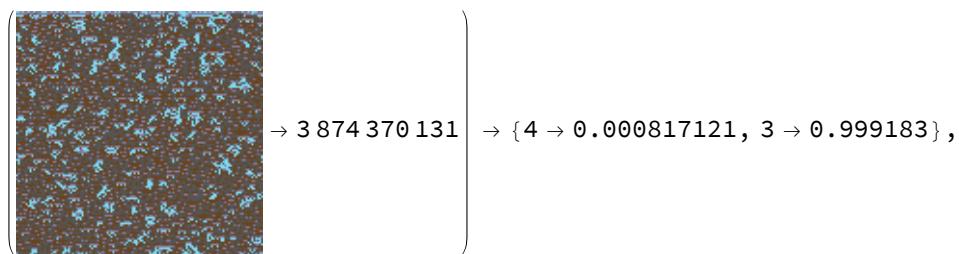
Out[]:= $\left\{ \begin{array}{l} \text{A 128x128 grid of dots showing a pattern of vertical stripes and diagonal lines, primarily blue and yellow.} \\ \rightarrow 3511876239 \end{array} \right\} \rightarrow \{2 \rightarrow 1.5807 \times 10^{-10}, 4 \rightarrow 1.\},$

Out[]:= $\left\{ \begin{array}{l} \text{A 128x128 grid of dots showing a complex, symmetric fractal-like pattern in yellow and green.} \\ \rightarrow 1629765289 \end{array} \right\} \rightarrow \{4 \rightarrow 1.84811 \times 10^{-17}, 3 \rightarrow 1.\},$

Out[]:= $\left\{ \begin{array}{l} \text{A 128x128 grid of dots showing a dense, noisy pattern of red and orange dots.} \\ \rightarrow 3309785711 \end{array} \right\} \rightarrow \{4 \rightarrow 5.75659 \times 10^{-20}, 3 \rightarrow 1.\},$

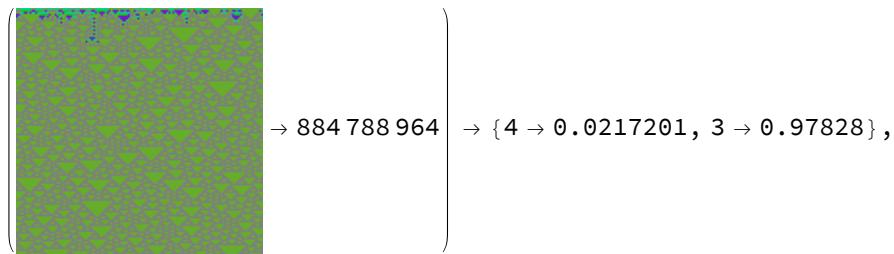
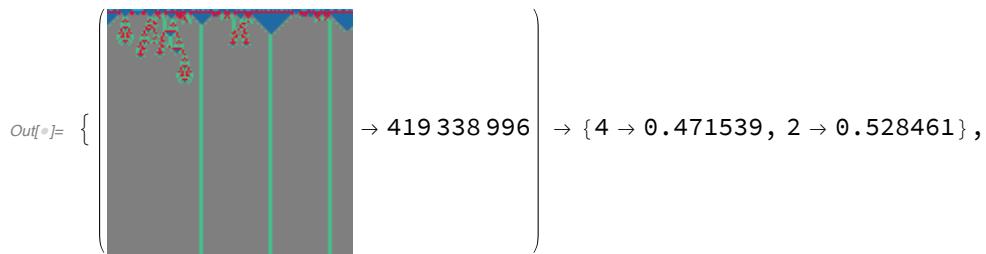
Out[]:= $\left\{ \begin{array}{l} \text{A 128x128 grid of dots showing a sparse, scattered pattern of cyan and black dots.} \\ \rightarrow 521880538 \end{array} \right\} \rightarrow \{4 \rightarrow 2.42952 \times 10^{-8}, 3 \rightarrow 1.\},$

Out[]:= $\left\{ \begin{array}{l} \text{A 128x128 grid of dots showing a highly irregular, noisy pattern of black and green dots.} \\ \rightarrow 2882903289 \end{array} \right\} \rightarrow \{4 \rightarrow 0.00262183, 3 \rightarrow 0.997378\},$



5-colour totalistic, range 1

```
In[8]:= test4Data5kr1C18 = data5T2C[8, 128, 128];
Thread[
  test4Data5kr1C18 → netECA18[Keys@test4Data5kr1C18, {"TopProbabilities", 2}]]
```



$$\left(\begin{array}{c} \text{[A 2x2 grid of colored dots]} \\ \rightarrow 743\ 542\ 029 \end{array} \right) \rightarrow \{3 \rightarrow 1.08355 \times 10^{-9}, 4 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 2x2 grid of colored dots]} \\ \rightarrow 782\ 108\ 342 \end{array} \right) \rightarrow \{4 \rightarrow 3.73846 \times 10^{-6}, 3 \rightarrow 0.999996\},$$

$$\left(\begin{array}{c} \text{[A 2x2 grid of colored dots]} \\ \rightarrow 785\ 621\ 045 \end{array} \right) \rightarrow \{4 \rightarrow 1.13554 \times 10^{-10}, 3 \rightarrow 1.\},$$

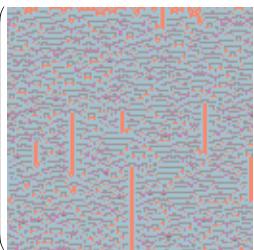
$$\left(\begin{array}{c} \text{[A 2x2 grid of colored dots]} \\ \rightarrow 540\ 834\ 160 \end{array} \right) \rightarrow \{4 \rightarrow 0.0000100212, 3 \rightarrow 0.99999\},$$

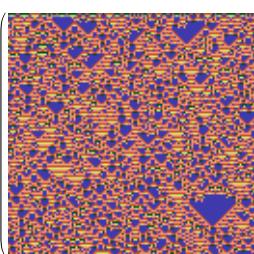
$$\left(\begin{array}{c} \text{[A 2x2 grid of colored dots]} \\ \rightarrow 1\ 180\ 125\ 611 \end{array} \right) \rightarrow \{3 \rightarrow 8.69272 \times 10^{-10}, 4 \rightarrow 1.\},$$

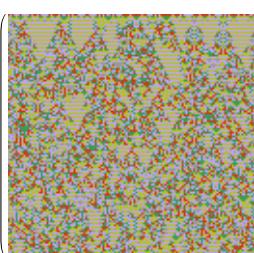
$$\left(\begin{array}{c} \text{[A 2x2 grid of colored dots]} \\ \rightarrow 604\ 699\ 906 \end{array} \right) \rightarrow \{4 \rightarrow 5.02809 \times 10^{-11}, 3 \rightarrow 1.\}$$

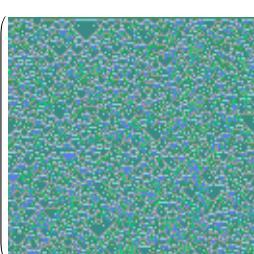
6-colour totalistic, range 1

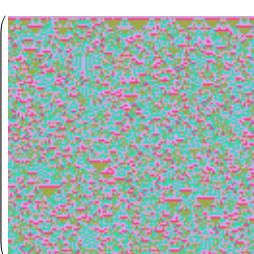
```
In[]:= test4Data6kr1C18 = data6TC[8, 128, 128];
Thread[
  test4Data6kr1C18 → netECA18[Keys@test4Data6kr1C18, {"TopProbabilities", 2}]]
```

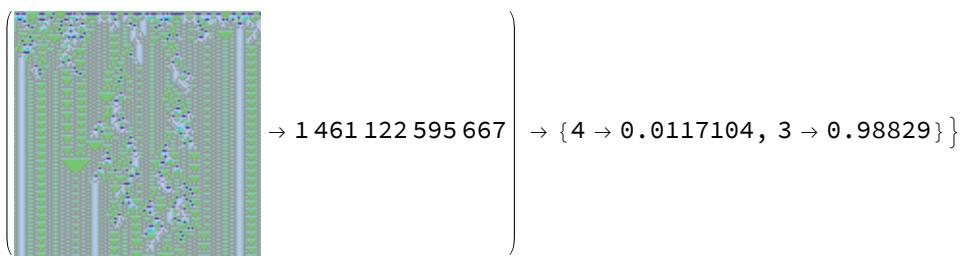
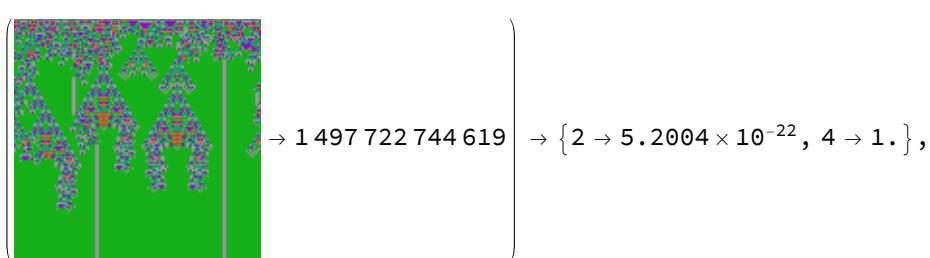
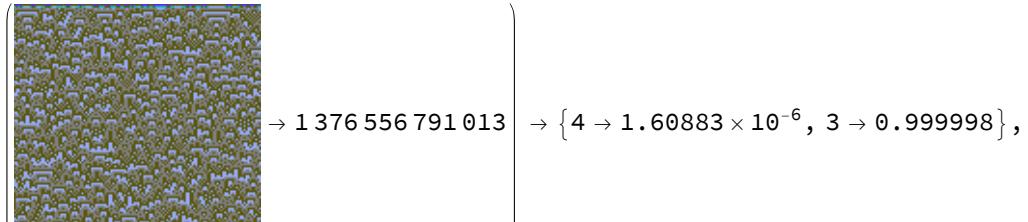
Out[]:= { → 1 598 104 240 744} → {4 → 0.385354, 3 → 0.614646},

{ → 2 744 610 103 617} → {4 → 4.14684 × 10⁻¹², 3 → 1.},

{ → 2 679 723 007 553} → {4 → 0.0146554, 3 → 0.985345},

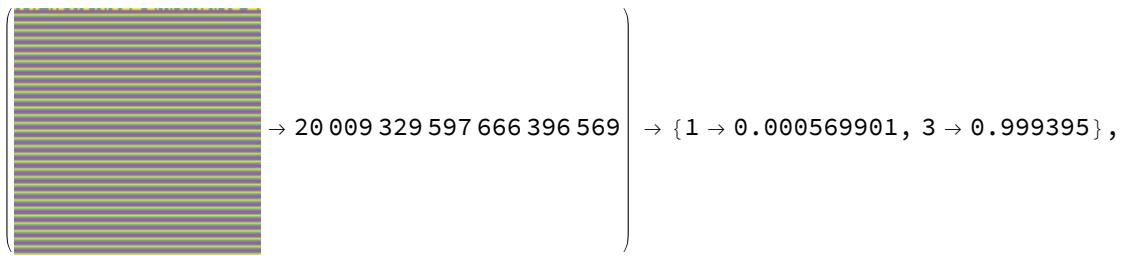
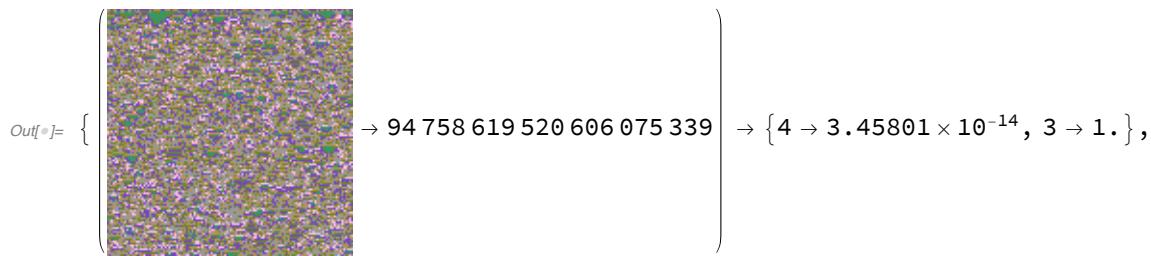
{ → 333 206 194 422} → {4 → 1.77212 × 10⁻⁶, 3 → 0.999998},

{ → 385 745 608 648} → {4 → 4.96414 × 10⁻¹⁸, 3 → 1.},



6-colour totalistic, range 2

```
In[]:= test4Data6kr2C18 = data6T2C[8, 128, 128];
Thread[
  test4Data6kr2C18 → netECA18[Keys@test4Data6kr2C18, {"TopProbabilities", 2}]]
```



$$\left(\begin{array}{c} \text{[A 4x3 grid of random colors]} \\ \rightarrow 143\ 751\ 744\ 015\ 528\ 766\ 387 \end{array} \right) \rightarrow \{4 \rightarrow 4.63781 \times 10^{-12}, 3 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 4x3 grid of random colors]} \\ \rightarrow 14\ 907\ 007\ 420\ 911\ 525\ 245 \end{array} \right) \rightarrow \{4 \rightarrow 2.71632 \times 10^{-7}, 3 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 4x3 grid of random colors]} \\ \rightarrow 153\ 725\ 842\ 134\ 059\ 084\ 151 \end{array} \right) \rightarrow \{4 \rightarrow 8.53867 \times 10^{-11}, 3 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 4x3 grid of random colors]} \\ \rightarrow 21\ 849\ 107\ 846\ 366\ 361\ 856 \end{array} \right) \rightarrow \{4 \rightarrow 4.26147 \times 10^{-8}, 3 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 4x3 grid of random colors]} \\ \rightarrow 39\ 897\ 609\ 306\ 289\ 130\ 946 \end{array} \right) \rightarrow \{4 \rightarrow 3.43225 \times 10^{-8}, 3 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 4x3 grid of random colors]} \\ \rightarrow 24\ 452\ 844\ 112\ 980\ 510\ 505 \end{array} \right) \rightarrow \{3 \rightarrow 2.30799 \times 10^{-17}, 4 \rightarrow 1.\}\}$$

7-colour totalistic, range 1

```
In[]:= test4Data7kr1C18 = data7TC[8, 128, 128];
Thread[
  test4Data7kr1C18 → netECA18[Keys@test4Data7kr1C18, {"TopProbabilities", 2}]]
```

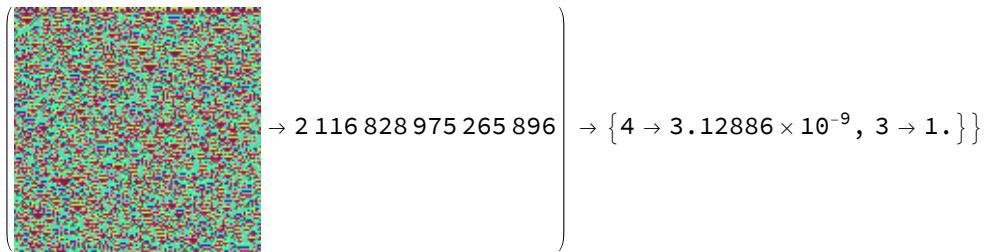
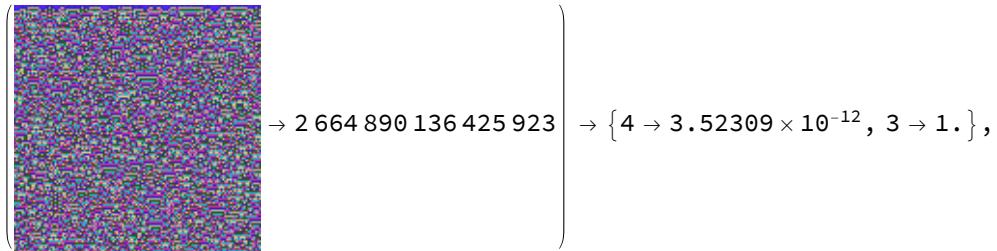
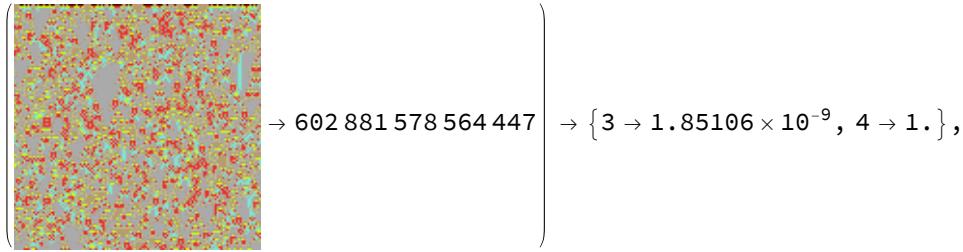
Out[]:= $\left\{ \begin{array}{c} \text{A 128x128 grid of 7 colors (red, green, blue, yellow, cyan, magenta, black) showing a pattern of vertical stripes.} \\ \rightarrow 9377524399313965 \end{array} \right\} \rightarrow \{3 \rightarrow 1.74389 \times 10^{-8}, 4 \rightarrow 1.\},$

Out[]:= $\left\{ \begin{array}{c} \text{A 128x128 grid of 7 colors showing a complex, noisy pattern with horizontal bands of different colors.} \\ \rightarrow 4962953862340599 \end{array} \right\} \rightarrow \{4 \rightarrow 0.0137316, 3 \rightarrow 0.986268\},$

Out[]:= $\left\{ \begin{array}{c} \text{A 128x128 grid of 7 colors showing a dense, granular pattern where most cells are black or dark gray.} \\ \rightarrow 8745570953687246 \end{array} \right\} \rightarrow \{4 \rightarrow 2.19284 \times 10^{-7}, 3 \rightarrow 1.\},$

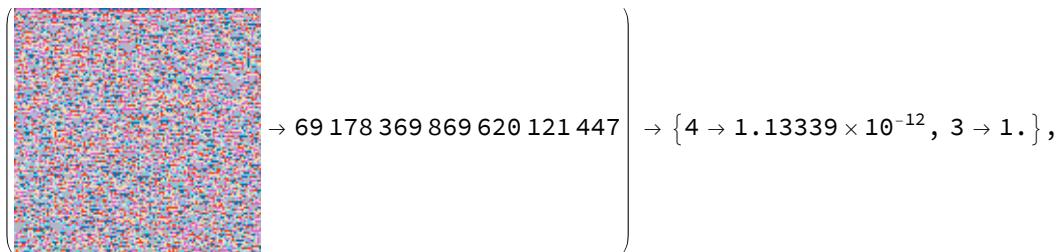
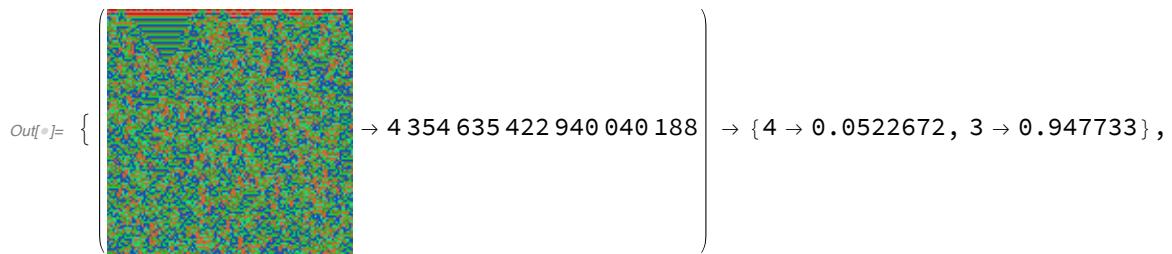
Out[]:= $\left\{ \begin{array}{c} \text{A 128x128 grid of 7 colors showing a sparse pattern of yellow and orange cells on a blue background.} \\ \rightarrow 5868018872447407 \end{array} \right\} \rightarrow \{4 \rightarrow 0.000111761, 3 \rightarrow 0.999888\},$

Out[]:= $\left\{ \begin{array}{c} \text{A 128x128 grid of 7 colors showing a dense pattern of red, green, and blue cells.} \\ \rightarrow 4309418628605253 \end{array} \right\} \rightarrow \{4 \rightarrow 1.75407 \times 10^{-6}, 3 \rightarrow 0.999998\},$



8-colour totalistic, range 1

```
In[]:= test4Data8kr1C18 = data8TC[8, 128, 128];
Thread[
  test4Data8kr1C18 → netECA18[Keys@test4Data8kr1C18, {"TopProbabilities", 2}]]
```



$$\left(\begin{array}{c} \text{Image 1: A 10x10 grid with various colored cells (red, green, blue, yellow, purple)} \\ \rightarrow 52\ 954\ 223\ 906\ 783\ 093\ 008 \end{array} \right) \rightarrow \{3 \rightarrow 7.29147 \times 10^{-15}, 4 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{Image 2: A 10x10 grid with mostly red and green cells, some blue and yellow} \\ \rightarrow 68\ 658\ 165\ 468\ 973\ 438\ 000 \end{array} \right) \rightarrow \{4 \rightarrow 1.9166 \times 10^{-11}, 3 \rightarrow 1.\},$$

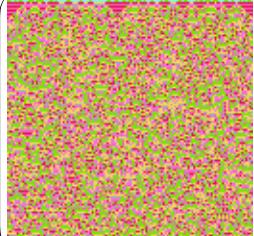
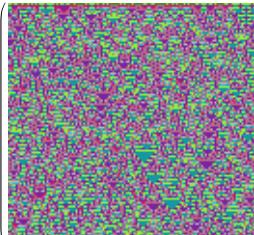
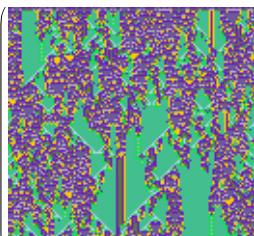
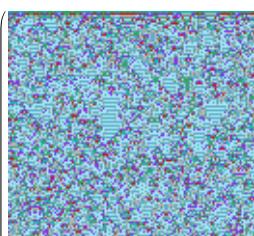
$$\left(\begin{array}{c} \text{Image 3: A 10x10 grid with mostly blue and green cells, some red and yellow} \\ \rightarrow 40\ 882\ 704\ 313\ 683\ 534\ 715 \end{array} \right) \rightarrow \{4 \rightarrow 0.0000183002, 3 \rightarrow 0.999982\},$$

$$\left(\begin{array}{c} \text{Image 4: A 10x10 grid with mostly green and blue cells, some red and yellow} \\ \rightarrow 4\ 334\ 236\ 228\ 138\ 547\ 400 \end{array} \right) \rightarrow \{4 \rightarrow 1.8216 \times 10^{-12}, 3 \rightarrow 1.\},$$

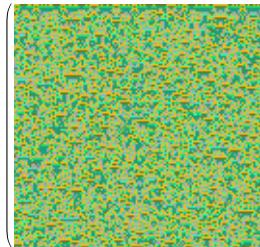
$$\left(\begin{array}{c} \text{Image 5: A 10x10 grid with mostly yellow and green cells, some red and blue} \\ \rightarrow 38\ 056\ 813\ 477\ 139\ 716\ 563 \end{array} \right) \rightarrow \{4 \rightarrow 0.025224, 3 \rightarrow 0.974776\},$$

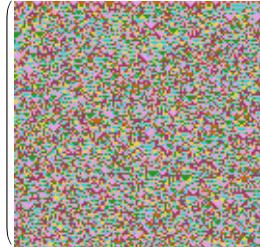
$$\left(\begin{array}{c} \text{Image 6: A 10x10 grid with mostly yellow and blue cells, some red and green} \\ \rightarrow 17\ 144\ 034\ 197\ 046\ 476\ 300 \end{array} \right) \rightarrow \{4 \rightarrow 1.1918 \times 10^{-10}, 3 \rightarrow 1.\}$$

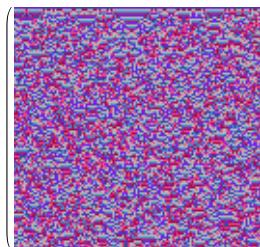
```
In[8]:= test4Data8kr1C18 = data8TC[8, 128, 128];
Thread[
  test4Data8kr1C18 → netECA18[Keys@test4Data8kr1C18, {"TopProbabilities", 2}]]
```

Out[8]= { → 27 295 602 810 117 462 452,  → 68 187 226 482 692 112 227,  → 26 338 422 679 712 858 793,  → 20 106 191 194 925 098 456,  → 27 427 530 853 867 733 909}

→ {4 → 1.93716×10^{-14} , 3 → 1.},
 → {4 → 1.97888×10^{-15} , 3 → 1.},
 → {2 → 1.54265×10^{-15} , 4 → 1.},
 → {4 → 1.32784×10^{-9} , 3 → 1.},
 → {3 → 7.69696×10^{-6} , 4 → 0.999992},

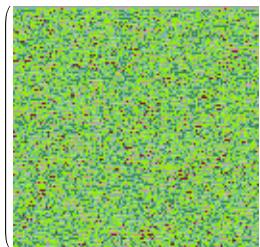
 → 67 626 281 665 658 424 537 } → { 4 → 1.31383×10^{-8} , 3 → 1. },

 → 25 326 375 293 896 897 208 } → { 4 → 9.39517×10^{-8} , 3 → 1. },

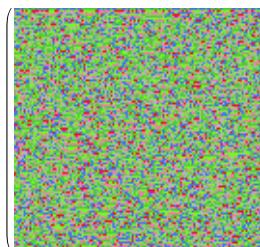
 → 17 284 363 590 068 343 962 } → { 4 → 0.000164327, 3 → 0.999836 }

8-colour totalistic, range 2

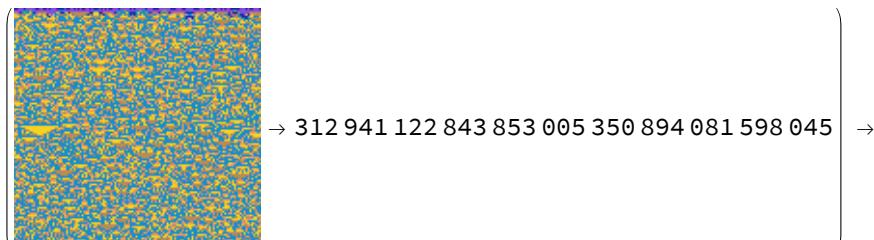
```
In[]:= test4Data8kr2C18 = data8T2C[8, 128, 128];
Thread[
  test4Data8kr2C18 → netECA18[Keys@test4Data8kr2C18, {"TopProbabilities", 2}]]
```

Out[]:= { → 91 605 229 994 459 866 473 701 555 510 459 } →

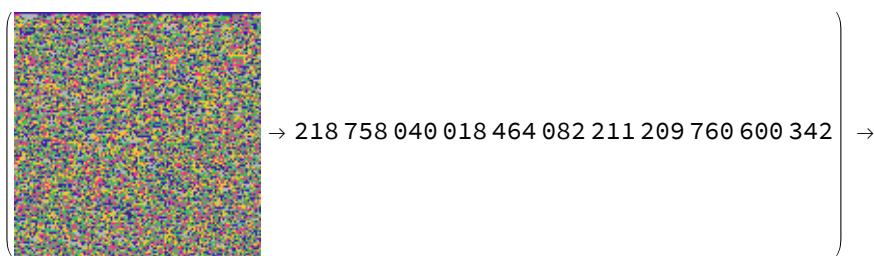
{ 4 → 8.95721×10^{-9} , 3 → 1. },

 → 148 194 329 210 486 766 360 332 149 681 908 } →

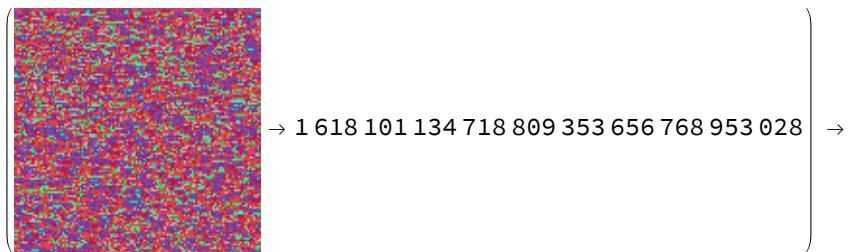
{ 4 → 0.000259168, 3 → 0.999741 },



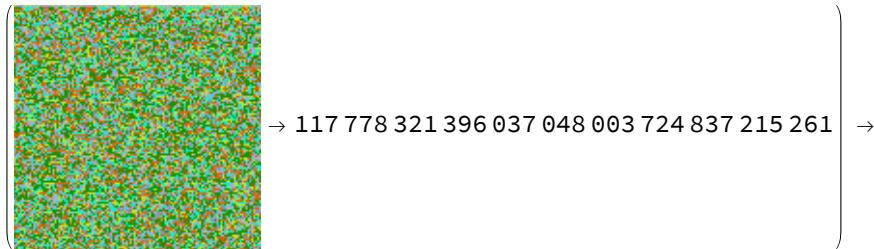
$\{4 \rightarrow 3.01437 \times 10^{-25}, 3 \rightarrow 1.\},$



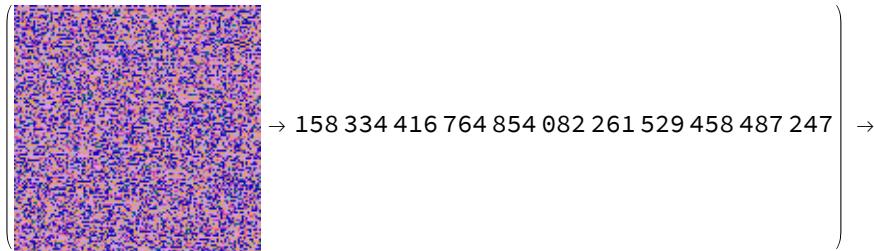
$\{4 \rightarrow 1.84707 \times 10^{-6}, 3 \rightarrow 0.999998\},$



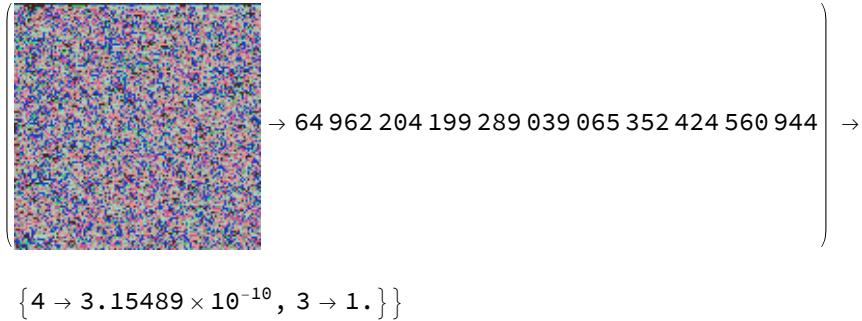
$\{4 \rightarrow 8.91462 \times 10^{-12}, 3 \rightarrow 1.\},$



$\{4 \rightarrow 1.56349 \times 10^{-7}, 3 \rightarrow 1.\},$

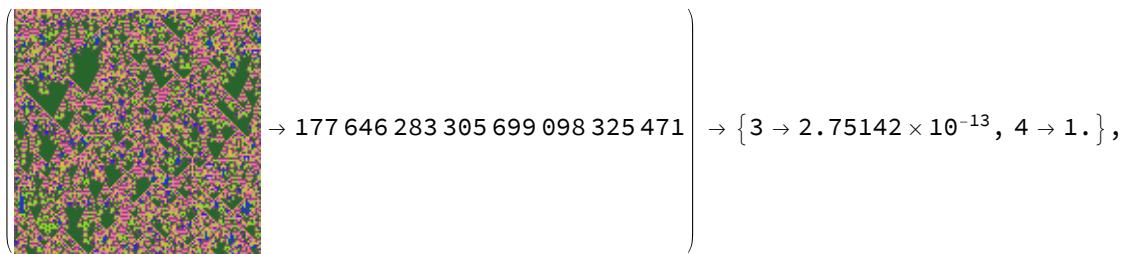
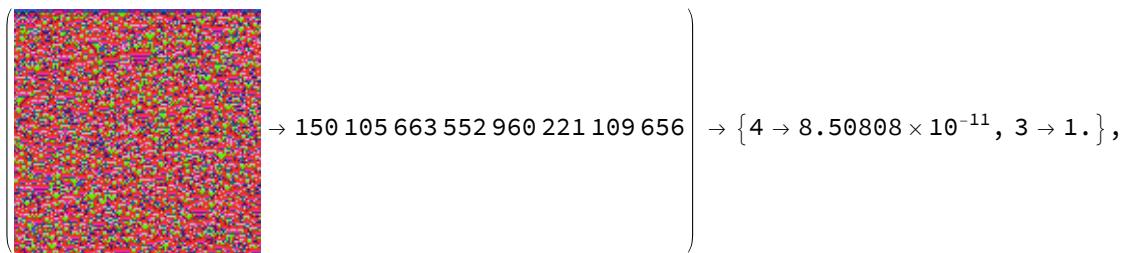
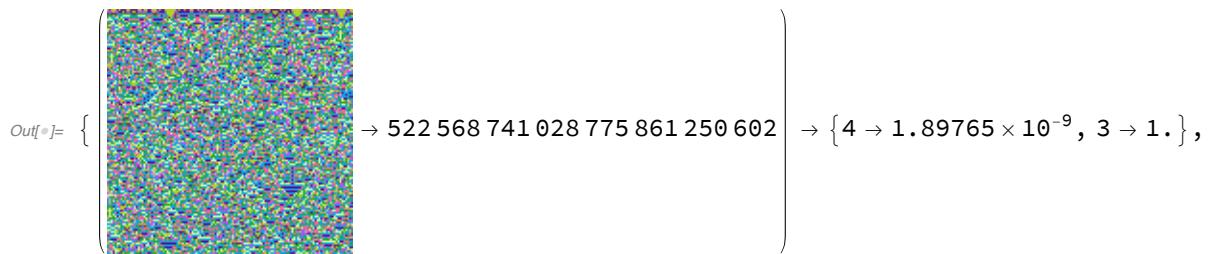


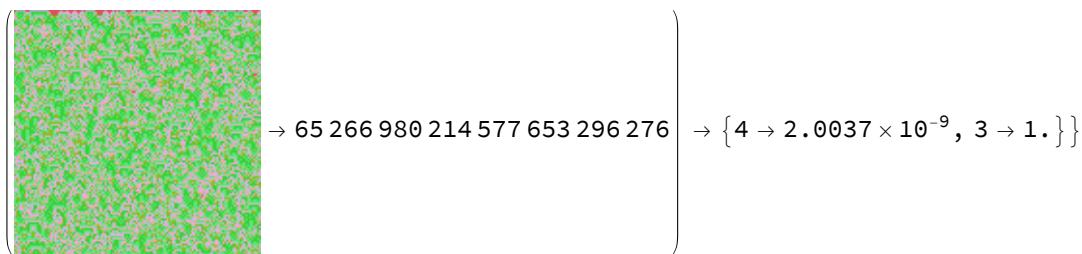
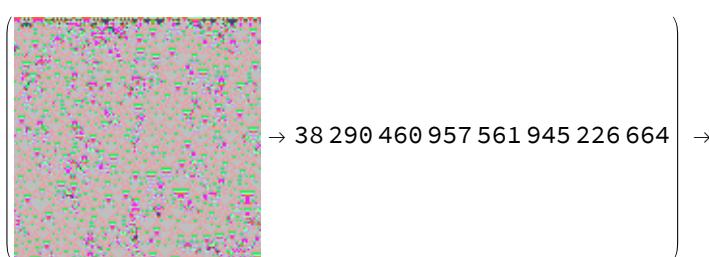
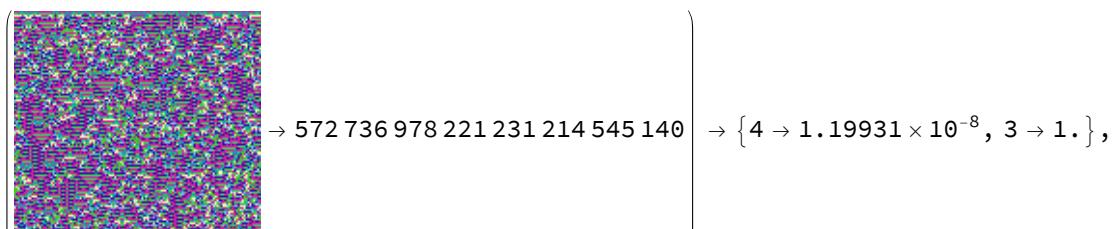
$\{3 \rightarrow 0.381514, 4 \rightarrow 0.618486\},$



9-colour totalistic, range 1

```
In[8]:= test4Data9kr1C18 = data9TC[8, 128, 128];
Thread[
  test4Data9kr1C18 &gt;> netECA18[Keys@test4Data9kr1C18, {"TopProbabilities", 2}]]
```

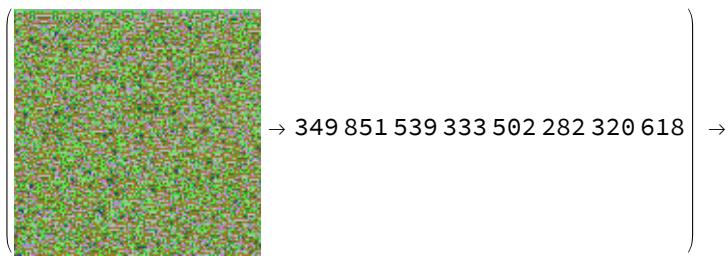
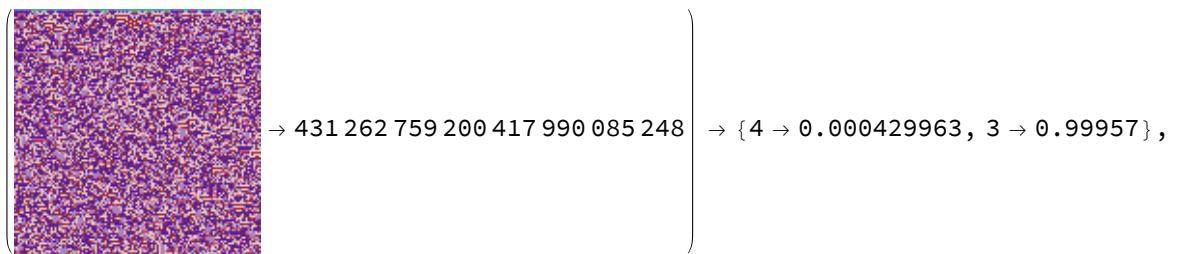
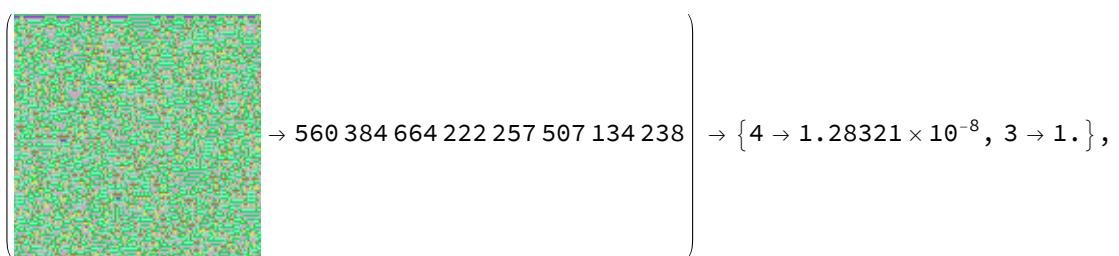
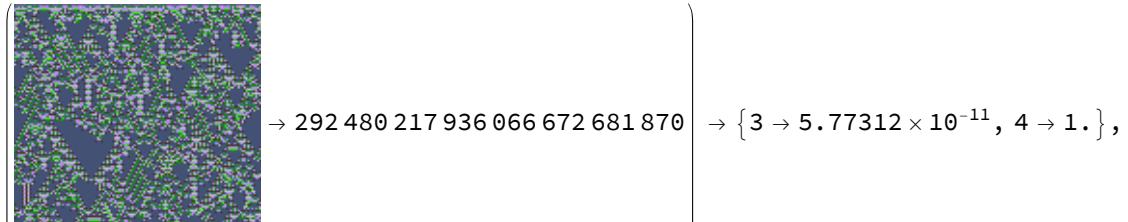




```
In[6]:= test4Data9kr1C18 = data9TC[8, 128, 128];
Thread[
test4Data9kr1C18 → netECA18[Keys@test4Data9kr1C18, {"TopProbabilities", 2}]]

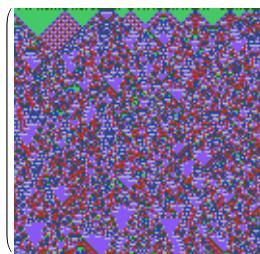
Out[6]= {
```

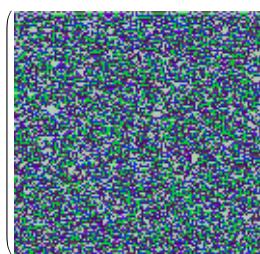
$\rightarrow \{4 \rightarrow 8.56952 \times 10^{-8}, 3 \rightarrow 1.\} ,$



$\{4 \rightarrow 5.50927 \times 10^{-7}, 3 \rightarrow 0.999999\},$

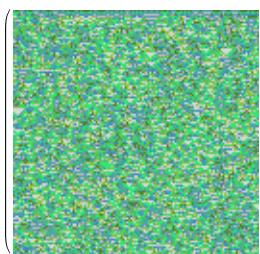
```

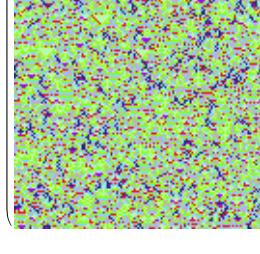

 $\rightarrow 141\ 618\ 270\ 878\ 027\ 879\ 702\ 319$ 
 $\left. \right\} \rightarrow$ 
 $\{4 \rightarrow 0.0000610287, 3 \rightarrow 0.999939\},$ 

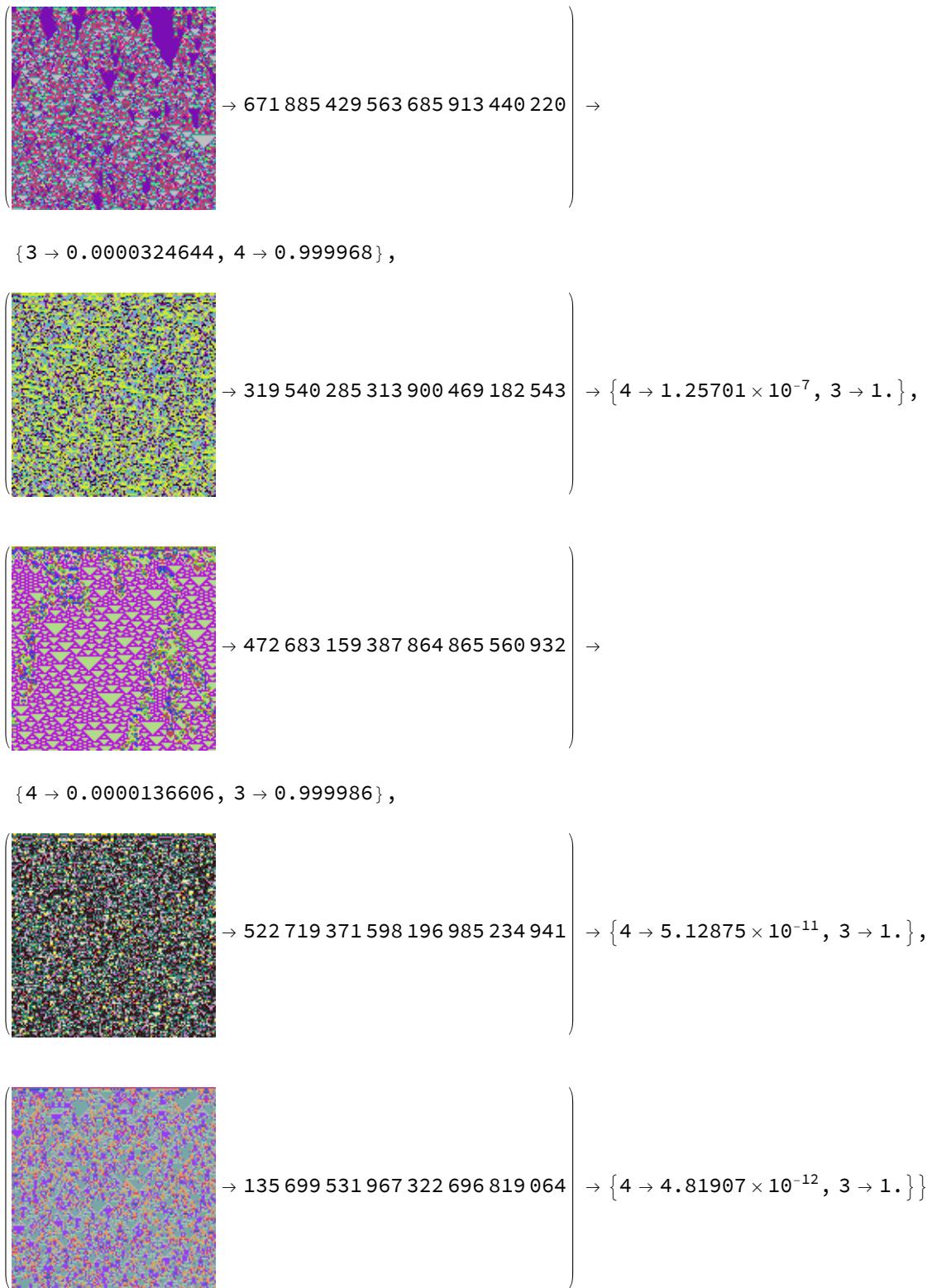

 $\rightarrow 401\ 516\ 309\ 538\ 894\ 848\ 288\ 118$ 
 $\left. \right\} \rightarrow \{4 \rightarrow 6.7734 \times 10^{-12}, 3 \rightarrow 1.\}\}$ 

In[8]:= test4Data9kr1C18 = data9TC[8, 128, 128];
Thread[
test4Data9kr1C18 \rightarrow netECA18[Keys@test4Data9kr1C18, {"TopProbabilities", 2}]]
```

Out[8]= {


 $\rightarrow 102\ 484\ 955\ 339\ 910\ 707\ 201\ 065$
 $\left. \right\} \rightarrow \{4 \rightarrow 2.85292 \times 10^{-12}, 3 \rightarrow 1.\},$

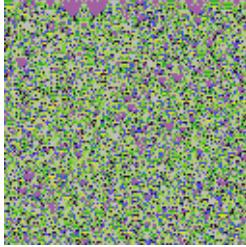
 $\rightarrow 225\ 104\ 493\ 515\ 167\ 213\ 968\ 116$
 $\left. \right\} \rightarrow \{4 \rightarrow 2.59132 \times 10^{-19}, 3 \rightarrow 1.\},$

 $\rightarrow 82\ 955\ 736\ 870\ 484\ 114\ 072\ 206$
 $\left. \right\} \rightarrow \{4 \rightarrow 7.69447 \times 10^{-10}, 3 \rightarrow 1.\},$

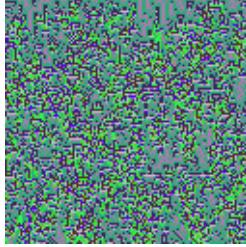


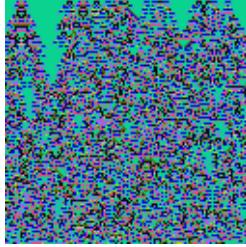
```

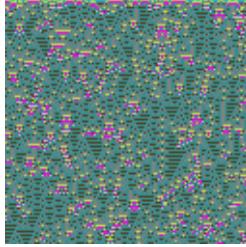
In[313]:= test4Data9kr1C18 = data9TC[8, 128, 128];
test4Data9kr1C18labeled = Thread[Labeled[
  Keys@test4Data9kr1C18, Values@test4Data9kr1C18, LabelStyle -> Small]];
Thread[test4Data9kr1C18labeled -> netECA18[Keys@test4Data9kr1C18,
 {"TopProbabilities", 2}]]

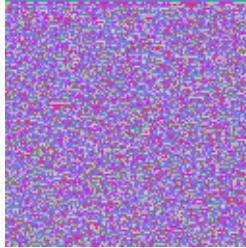
```

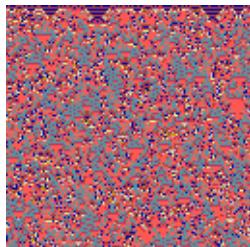
Out[315]= 
 $\rightarrow \{4 \rightarrow 3.42626 \times 10^{-14}, 3 \rightarrow 1.\},$
349 053 945 078 960 182 984 058


 $\rightarrow \{4 \rightarrow 2.76129 \times 10^{-8}, 3 \rightarrow 1.\},$
436 609 066 684 808 759 301 987


 $\rightarrow \{3 \rightarrow 3.31294 \times 10^{-20}, 4 \rightarrow 1.\},$
109 306 125 150 234 096 172 548

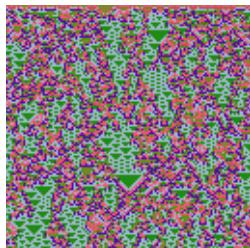

 $\rightarrow \{4 \rightarrow 0.00193157, 3 \rightarrow 0.998068\},$
418 672 174 548 024 537 683 242


 $\rightarrow \{4 \rightarrow 5.19538 \times 10^{-7}, 3 \rightarrow 0.999999\},$
384 634 547 406 938 511 788 486



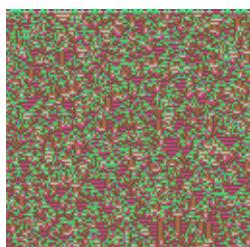
$$\rightarrow \{ 4 \rightarrow 6.78179 \times 10^{-9}, 3 \rightarrow 1. \},$$

395 758 960 768 423 349 691 715



$$\rightarrow \{ 4 \rightarrow 8.80994 \times 10^{-6}, 3 \rightarrow 0.999991 \},$$

396 890 553 438 981 909 112 518



$$\rightarrow \{ 4 \rightarrow 0.00035471, 3 \rightarrow 0.999645 \}$$

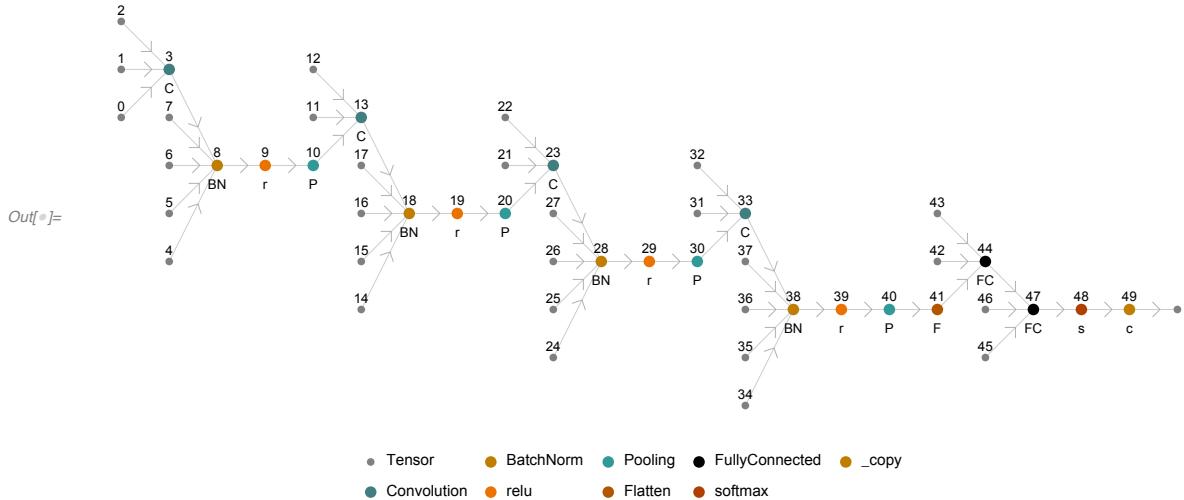
221 637 308 166 169 056 395 230

Network XIX - Four convolutions, dropout on linear only, BatchNorm, MaxPool

```
In[8]:= netECA19 = netElevenCC1024drop[128, 128]
```

	Input	image
conv1	ConvolutionLayer	array (size: 3 x 128 x 128)
bat1	BatchNormalizationLayer	array (size: 48 x 126 x 126)
ramp1	Ramp	array (size: 48 x 126 x 126)
pooling1	PoolingLayer	array (size: 48 x 125 x 125)
conv2	ConvolutionLayer	array (size: 24 x 123 x 123)
bat2	BatchNormalizationLayer	array (size: 24 x 123 x 123)
ramp2	Ramp	array (size: 24 x 123 x 123)
pooling2	PoolingLayer	array (size: 24 x 122 x 122)
conv3	ConvolutionLayer	array (size: 24 x 120 x 120)
bat3	BatchNormalizationLayer	array (size: 24 x 120 x 120)
ramp3	Ramp	array (size: 24 x 120 x 120)
pooling3	PoolingLayer	array (size: 24 x 119 x 119)
conv4	ConvolutionLayer	array (size: 12 x 117 x 117)
bat4	BatchNormalizationLayer	array (size: 12 x 117 x 117)
ramp4	Ramp	array (size: 12 x 117 x 117)
pooling4	PoolingLayer	array (size: 12 x 116 x 116)
flatten	FlattenLayer	vector (size: 161472)
linear	LinearLayer	vector (size: 1024)
drop2	DropoutLayer	vector (size: 1024)
linear2	LinearLayer	vector (size: 4)
softmax	SoftmaxLayer	vector (size: 4)
	Output	class

```
In[⑩]:= NetInformation[netECA19, "MXNetNodeGraphPlot"]
```



```
In[⑪]:= NetInformation[netECA19, "SummaryGraphic"]
```



```
In[⑫]:= dataECA19 = dataC[128, 128, 16 384];
```

```
In[⑬]:= dataTotalistic2BigC19 = genData2r2C[128, 128, 4096];
```

```
In[⑭]:= dataTotalistic3BigC19 = data3T2C[128, 128, 4096];
```

```
In[⑮]:= dataTotalistic4BigC19 = data4TC[128, 128, 4096];
```

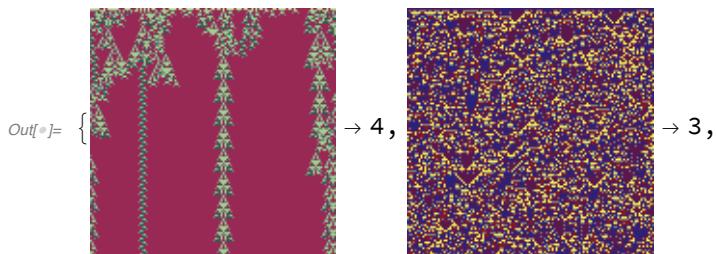
```
In[⑯]:= dataTotalistic5BigC19 = genData5TCC[128, 128, 16 384];
```

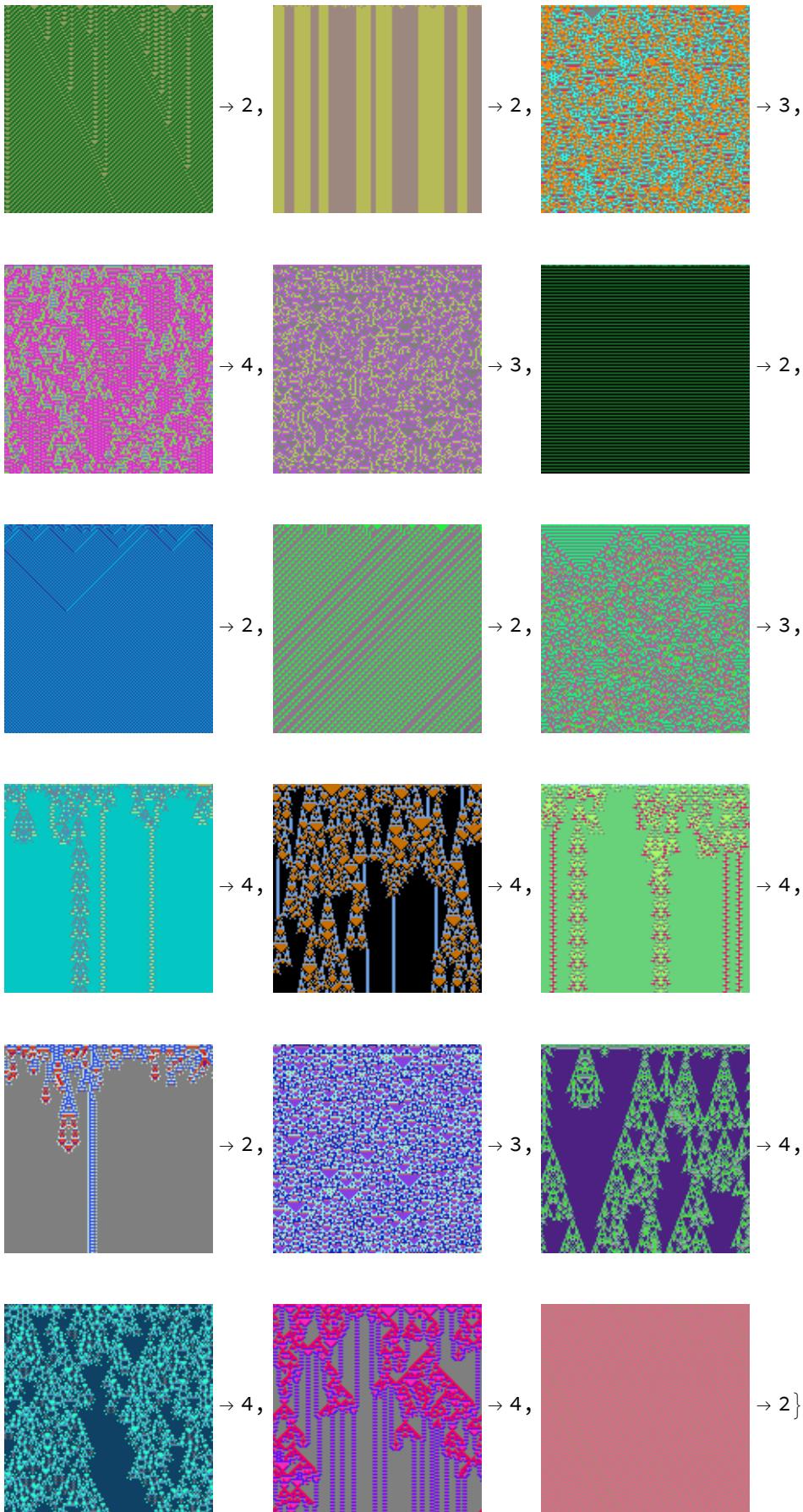
```
In[⑰]:= fullTrainingBigC19 = Join[dataECA19, dataTotalistic2BigC19,
    dataTotalistic3BigC19, dataTotalistic4BigC19, dataTotalistic5BigC19];
```

```
In[⑱]:= Length[fullTrainingBigC19]
```

```
Out[⑱]= 90112
```

```
In[⑲]:= RandomSample[fullTrainingBigC19, 20]
```





```
In[6]:= dir = SetDirectory[NotebookDirectory[]]
Out[6]= /home/esilverman/Documents

In[7]:= netECA19 = NetTrain[netECA19, fullTrainingBigC19,
  MaxTrainingRounds → 200, BatchSize → 256, TargetDevice → "GPU",
  TrainingProgressCheckpointing → {"Directory", dir}]
```

Generate test data for Network XIX (200 epochs)

```
In[71]:= dir = SetDirectory[NotebookDirectory[]]
Out[71]= /Users/thorsilver/Downloads/Wolfram notebooks
```

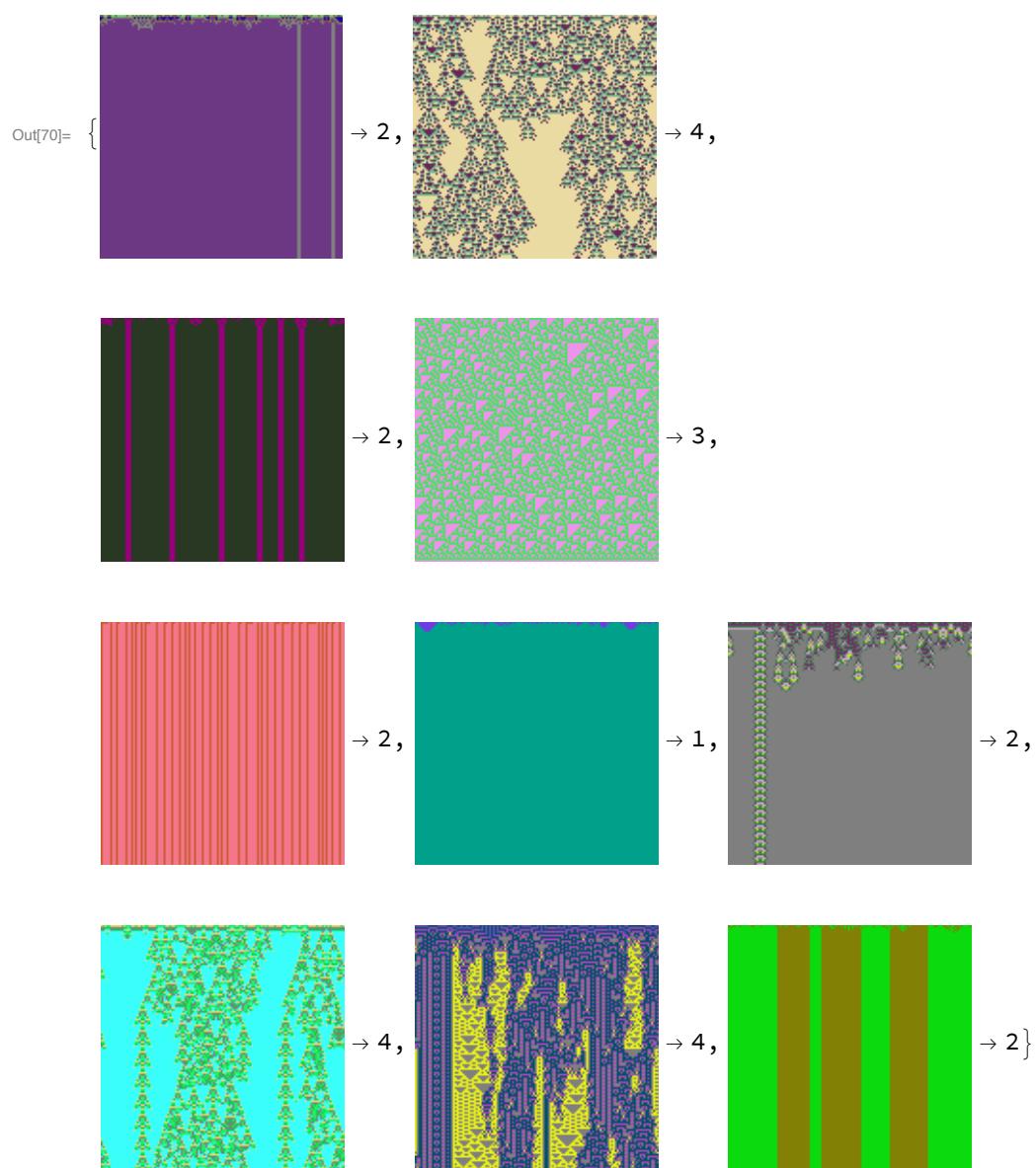
```
In[72]:= netECA19 = Import["netECA19-r200.wlnet"]
```

Out[72]=	NetChain[Input	image
		conv1	array (size: 3 × 128 × 128)
		bat1	array (size: 48 × 126 × 126)
		ramp1	array (size: 48 × 126 × 126)
		pooling1	array (size: 48 × 125 × 125)
		conv2	array (size: 24 × 123 × 123)
		bat2	BatchNormalizationLayer
		ramp2	Ramp
		pooling2	PoolingLayer
		conv3	ConvolutionLayer
		bat3	BatchNormalizationLayer
		ramp3	Ramp
		pooling3	PoolingLayer
		conv4	ConvolutionLayer
		bat4	BatchNormalizationLayer
		ramp4	Ramp
		pooling4	PoolingLayer
		flatten	FlattenLayer
		linear	LinearLayer
		drop2	DropoutLayer
		linear2	LinearLayer
		softmax	SoftmaxLayer
		Output	Output
			class

```
In[63]:= testDataECABigC = dataC[128, 128, 1024];
testData2TBigC = genData2r2C[128, 128, 1024];
testData3TBigC = data3T2C[128, 128, 1024];
testData4TBigC = data4TC[128, 128, 1024];
testData5TBigC = genData5TCC[128, 128, 1024];
fullTestSetBigC = Join[testDataECABigC,
  testData2TBigC, testData3TBigC, testData4TBigC, testData5TBigC];
Length[fullTestSetBigC]
```

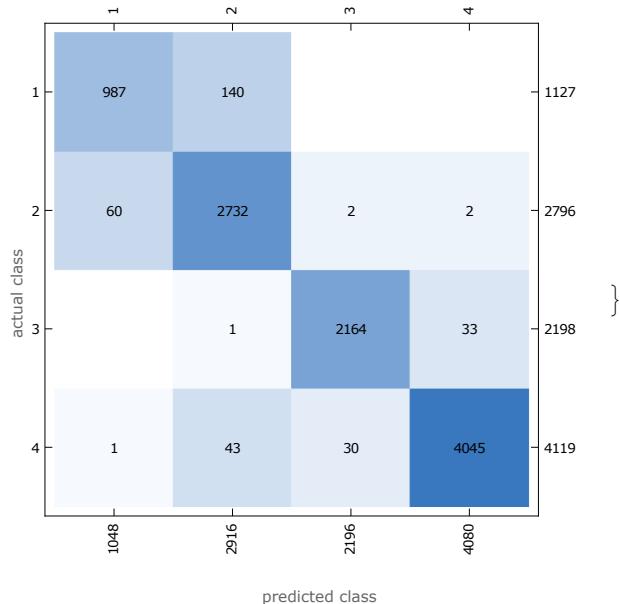
```
Out[69]= 10 240
```

```
In[70]:= RandomSample[fullTestSetBigC, 10]
```

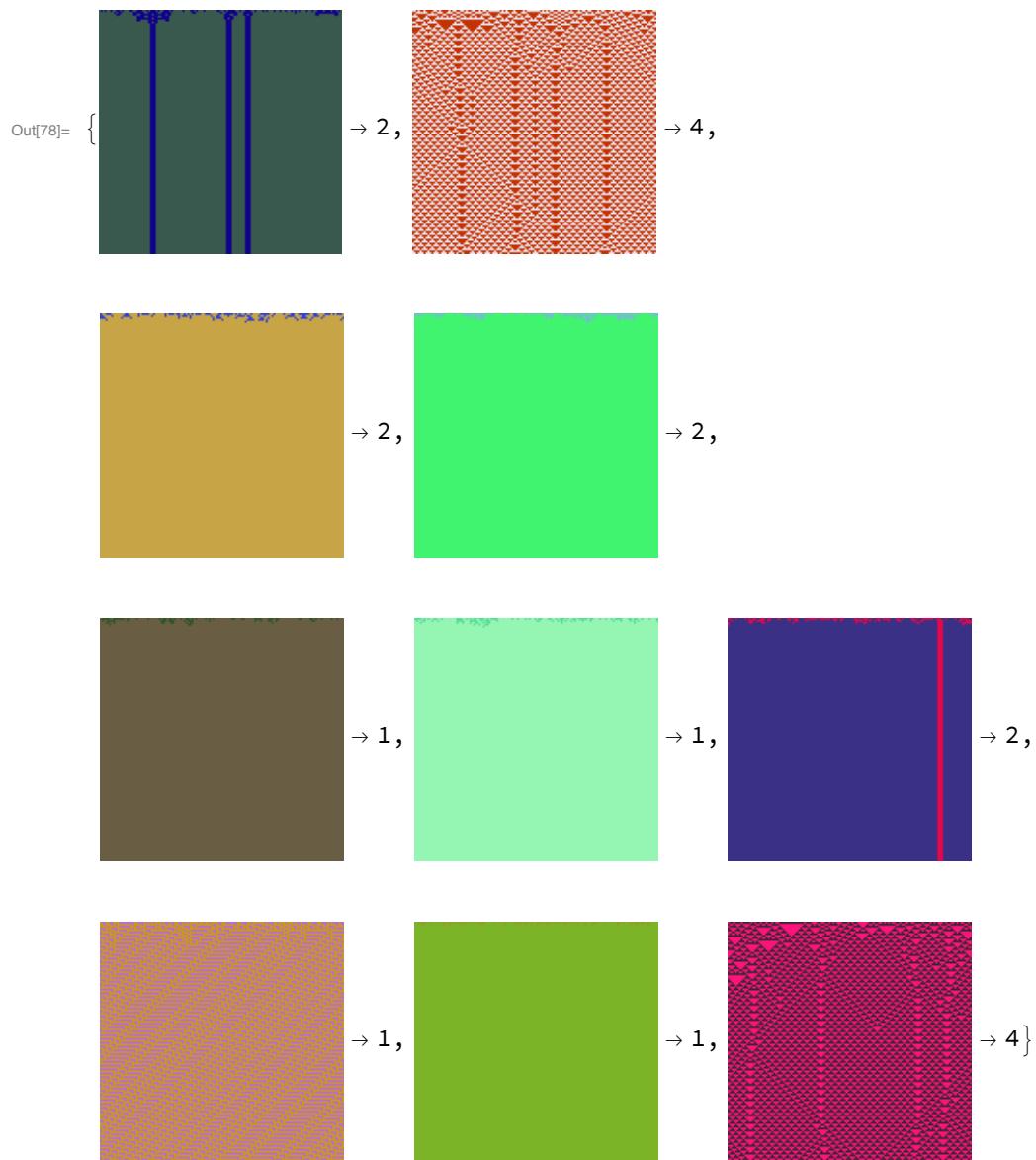


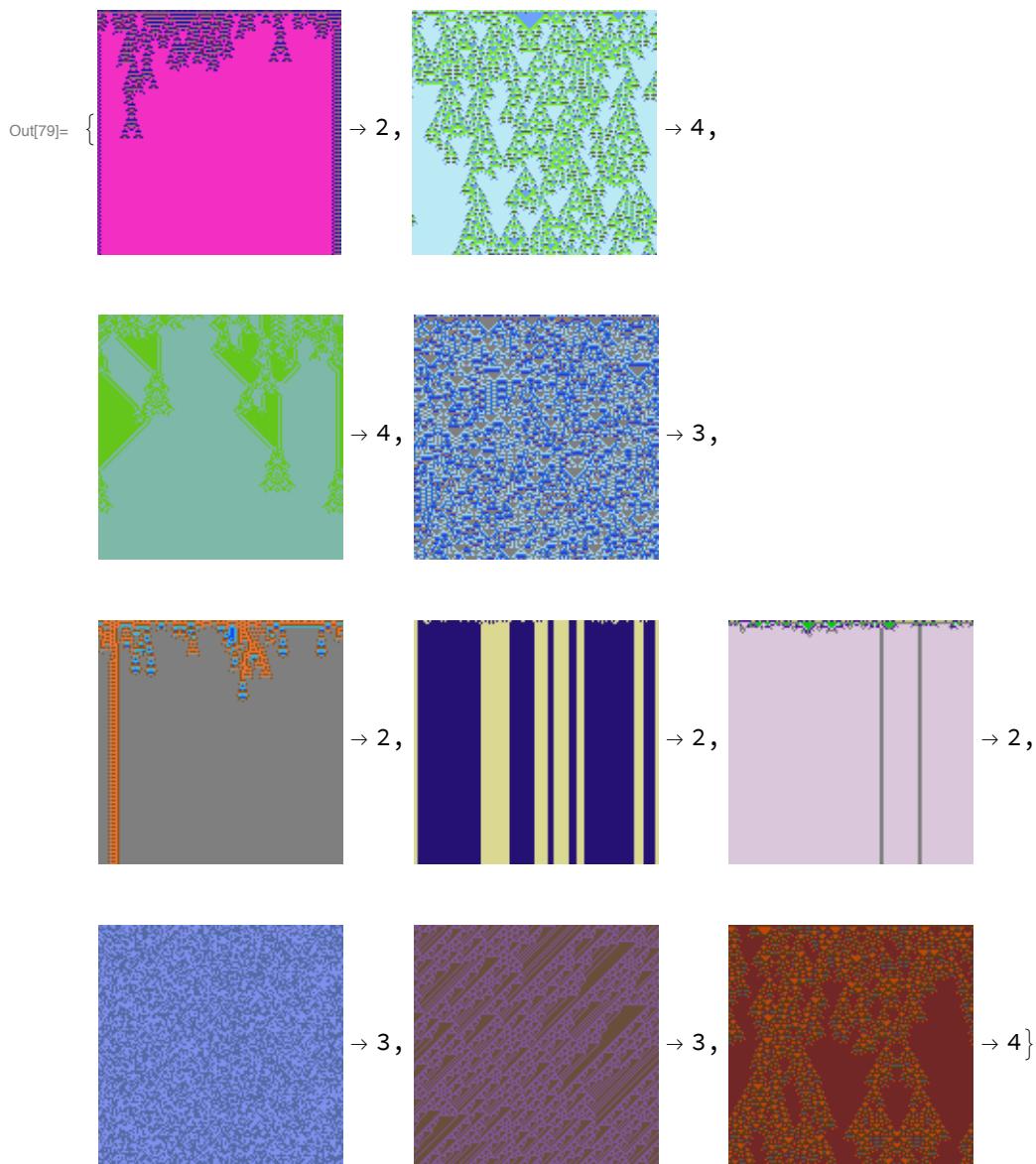
```
In[73]:= NetMeasurements[netECA19, fullTestSetBigC,
 {"Accuracy", "Precision", "ConfusionMatrixPlot"}]

Out[73]= {0.969531, {1 → 0.941794, 2 → 0.9369, 3 → 0.985428, 4 → 0.991422}, }
```



```
In[74]:= entropyImagesBigC = RandomSample[Keys[fullTestSetBigC], 500];
entropiesBigC = netECA19[entropyImagesBigC, "Entropy"];
highEntBigC = entropyImagesBigC[[Ordering[entropiesBigC, -10]]];
lowEntBigC = entropyImagesBigC[[Ordering[entropiesBigC, 10]]];
Thread[highEntBigC → netECA19[highEntBigC]]
Thread[lowEntBigC → netECA19[lowEntBigC]]
```





Testing Network XIX (200 epochs) on unseen CA rule spaces

2-colour non-totalistic, range 2

```
In[84]:= test4Data2kr2C19 = datak2r2C[128, 128, 8];
Thread[
  test4Data2kr2C19  $\rightarrow$  netECA19[Keys@test4Data2kr2C19, {"TopProbabilities", 2}]]
```

Out[85]= {

$\rightarrow 3\ 623\ 639\ 841$

$\left. \right\} \rightarrow \{4 \rightarrow 5.92466 \times 10^{-19}, 3 \rightarrow 1.\},$

$$\left(\begin{array}{c} \text{[A green pattern with vertical blue lines]} \\ \rightarrow 4\ 204\ 902\ 033 \end{array} \right) \rightarrow \{4 \rightarrow 2.56823 \times 10^{-8}, 2 \rightarrow 1.\},$$

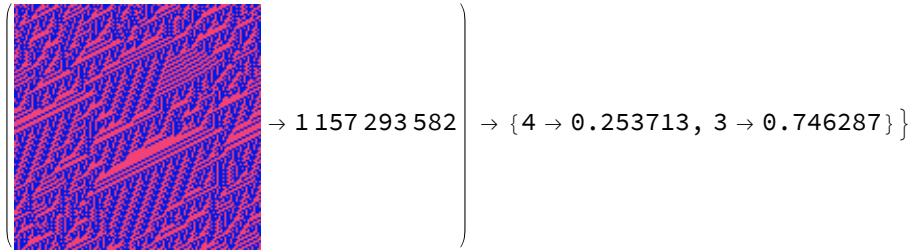
$$\left(\begin{array}{c} \text{[A pink pattern with diagonal black lines]} \\ \rightarrow 3\ 766\ 586\ 648 \end{array} \right) \rightarrow \{1 \rightarrow 0., 3 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A green pattern with small black dots]} \\ \rightarrow 3\ 083\ 711\ 710 \end{array} \right) \rightarrow \{4 \rightarrow 2.17708 \times 10^{-25}, 3 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A purple pattern with diagonal green lines]} \\ \rightarrow 3\ 912\ 062\ 127 \end{array} \right) \rightarrow \{1 \rightarrow 0., 2 \rightarrow 1.\},$$

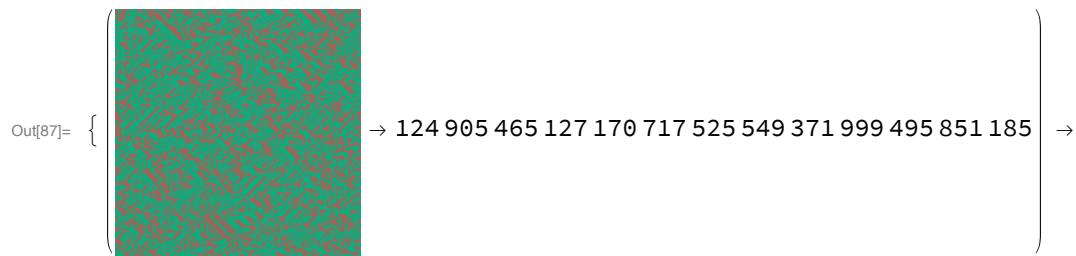
$$\left(\begin{array}{c} \text{[A pink pattern with small black dots]} \\ \rightarrow 3\ 127\ 103\ 417 \end{array} \right) \rightarrow \{1 \rightarrow 0., 3 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A blue pattern with small black dots]} \\ \rightarrow 1\ 368\ 223\ 734 \end{array} \right) \rightarrow \{3 \rightarrow 0.0375692, 4 \rightarrow 0.962431\},$$

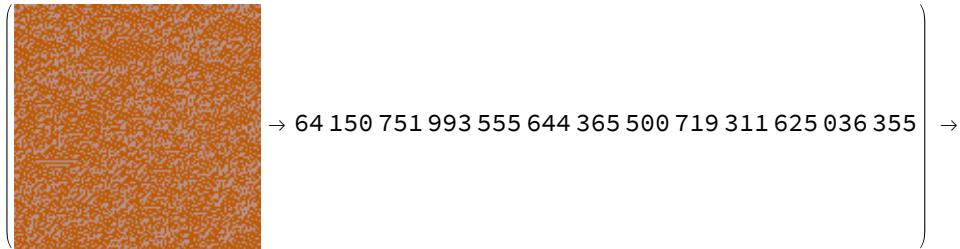


2-colour non-totalistic, range 3

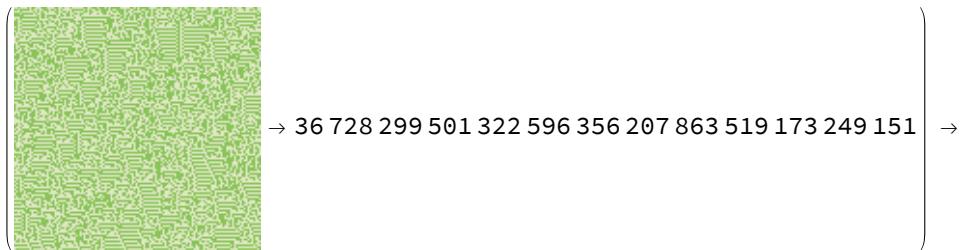
```
In[86]:= test4Data2kr3C19 = datak2r3NT[128, 128, 8];
Thread[
test4Data2kr3C19 \rightarrow netECA19[Keys@test4Data2kr3C19, {"TopProbabilities", 2}]]
```



$\{ 4 \rightarrow 4.25787 \times 10^{-22}, 3 \rightarrow 1. \},$



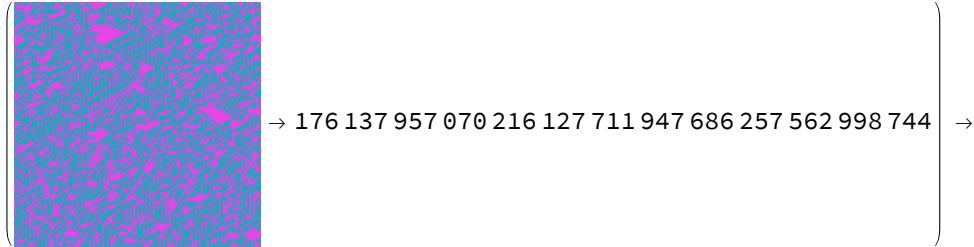
$\{ 4 \rightarrow 3.40968 \times 10^{-31}, 3 \rightarrow 1. \},$



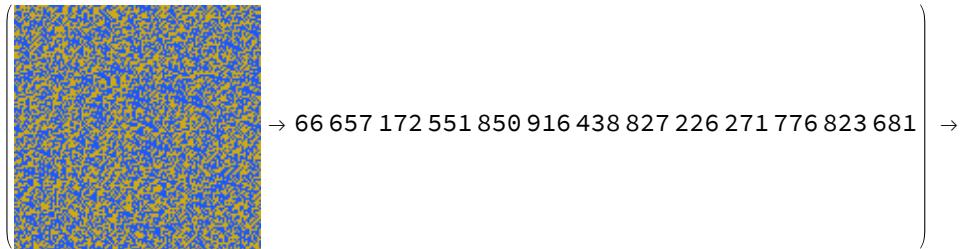
$\{ 4 \rightarrow 1.92235 \times 10^{-12}, 3 \rightarrow 1. \},$



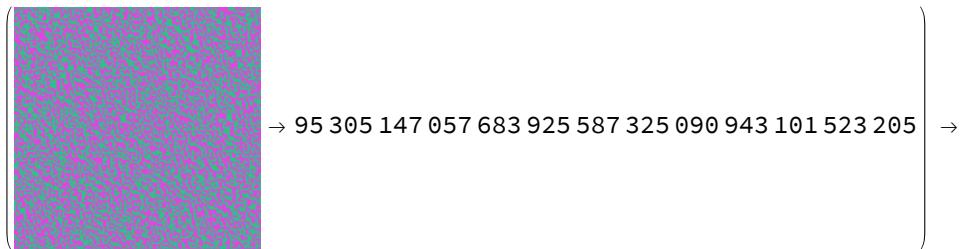
$\{3 \rightarrow 0.190559, 4 \rightarrow 0.809441\},$



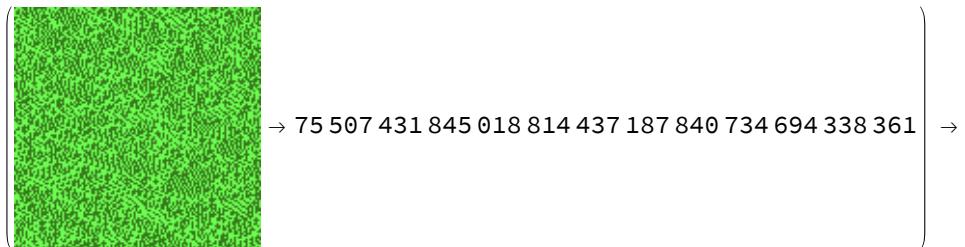
$\{1 \rightarrow 0., 3 \rightarrow 1.\},$



$\{4 \rightarrow 9.37229 \times 10^{-18}, 3 \rightarrow 1.\},$



$\{4 \rightarrow 1.7544 \times 10^{-26}, 3 \rightarrow 1.\},$



$\{4 \rightarrow 1.14088 \times 10^{-28}, 3 \rightarrow 1.\} \}$

3-colour non-totalistic, range 1

```
In[90]:= test4Data3kr1C19 = datak3r1NT[128, 128, 8];
Thread[
test4Data3kr1C19 → netECA19[Keys@test4Data3kr1C19, {"TopProbabilities", 2}]]
```

Out[91]= $\left\{ \begin{array}{c} \text{(A green square pattern)} \\ \rightarrow 903\ 740\ 772\ 813 \end{array} \right\} \rightarrow \{4 \rightarrow 1.43387 \times 10^{-14}, 3 \rightarrow 1.\},$

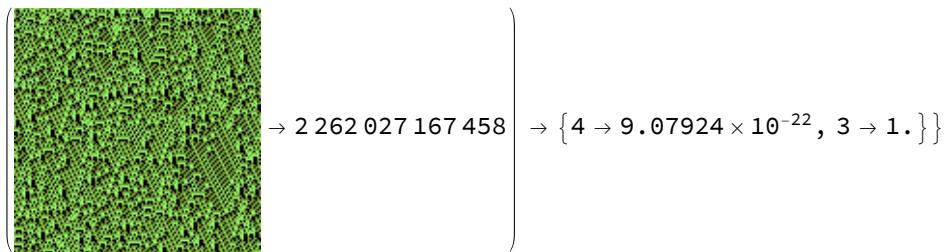
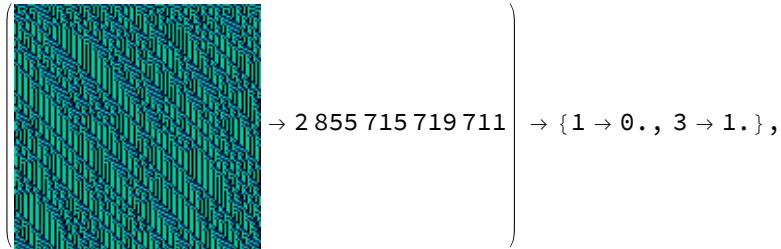
$\left\{ \begin{array}{c} \text{(A pattern with magenta diagonal stripes)} \\ \rightarrow 4\ 969\ 181\ 144\ 217 \end{array} \right\} \rightarrow \{2 \rightarrow 0.0805151, 4 \rightarrow 0.919485\},$

$\left\{ \begin{array}{c} \text{(A purple square pattern)} \\ \rightarrow 7\ 038\ 367\ 528\ 689 \end{array} \right\} \rightarrow \{3 \rightarrow 8.64922 \times 10^{-26}, 4 \rightarrow 1.\},$

$\left\{ \begin{array}{c} \text{(A red square pattern with vertical stripes)} \\ \rightarrow 432\ 813\ 174\ 387 \end{array} \right\} \rightarrow \{4 \rightarrow 1.4013 \times 10^{-45}, 2 \rightarrow 1.\},$

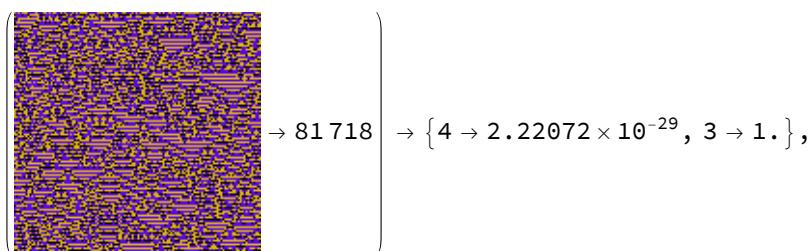
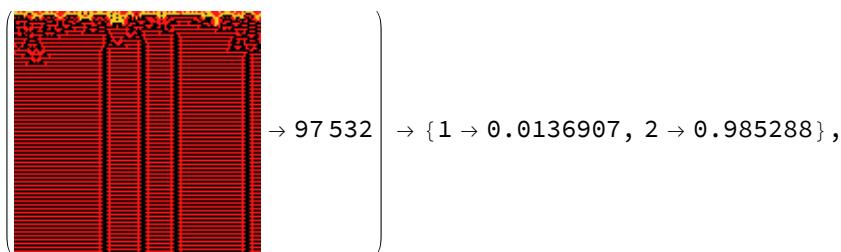
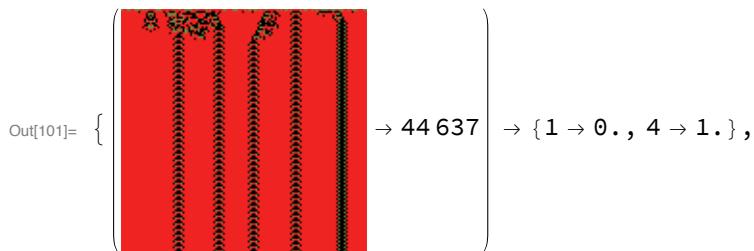
$\left\{ \begin{array}{c} \text{(A green square pattern with complex internal structure)} \\ \rightarrow 2\ 083\ 475\ 355\ 420 \end{array} \right\} \rightarrow \{4 \rightarrow 1.38076 \times 10^{-8}, 3 \rightarrow 1.\},$

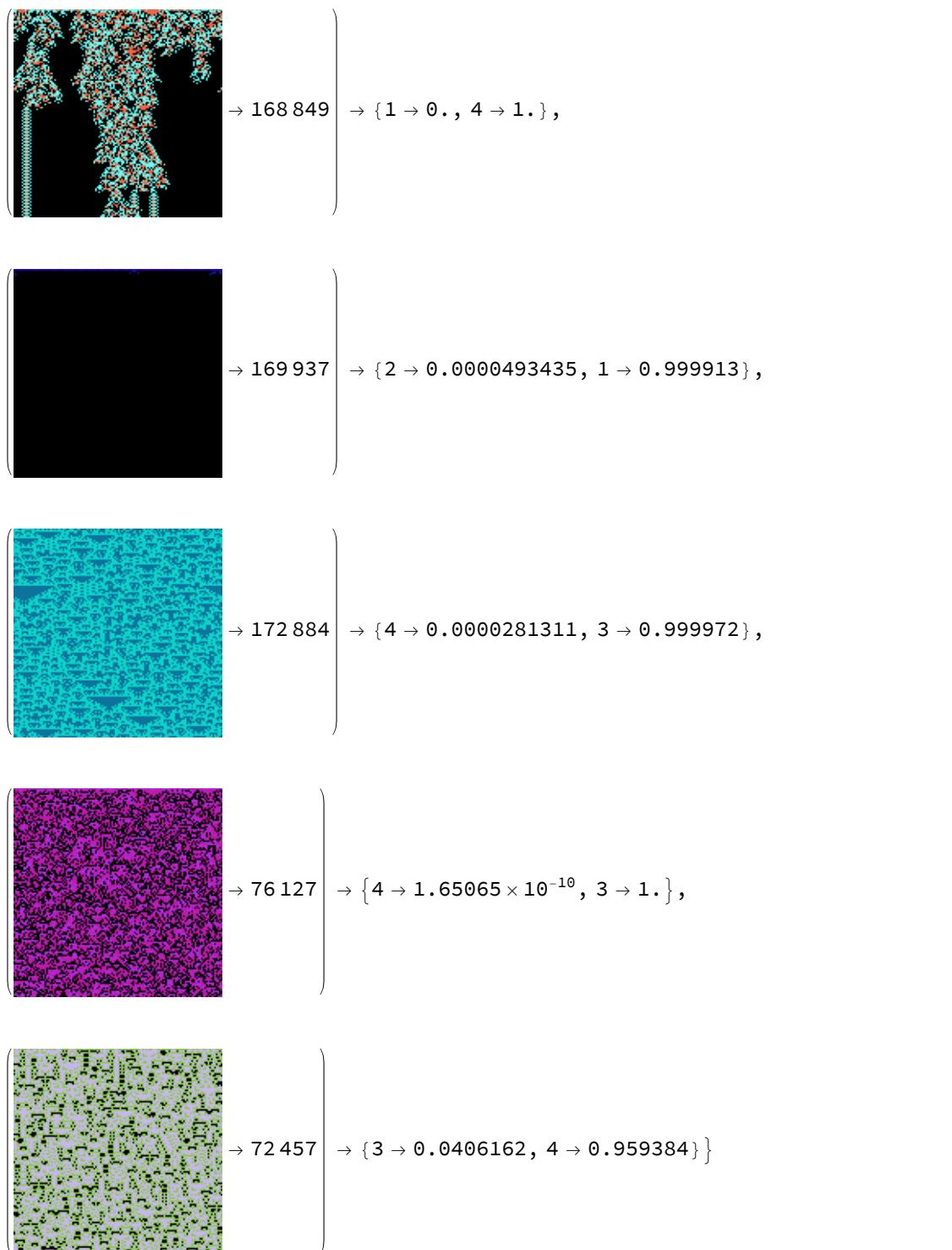
$\left\{ \begin{array}{c} \text{(A green square pattern with concentric bands)} \\ \rightarrow 966\ 244\ 316\ 659 \end{array} \right\} \rightarrow \{4 \rightarrow 8.30269 \times 10^{-33}, 3 \rightarrow 1.\},$



3-colour totalistic, range 2

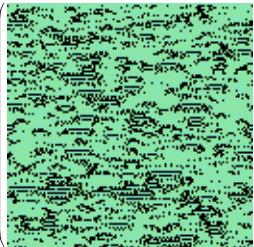
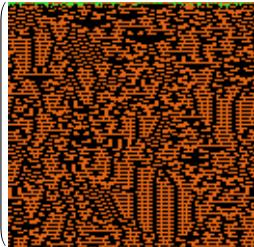
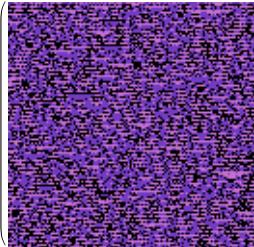
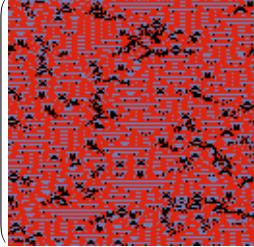
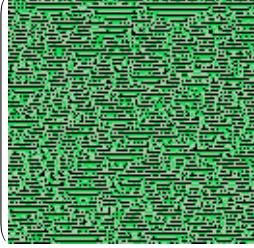
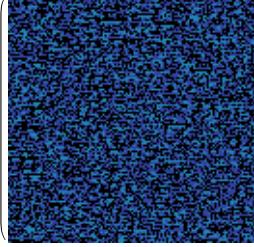
```
In[100]:= test4Data3kr2C19 = datak3r2C[128, 128, 8];
Thread[
  test4Data3kr2C19 → netECA19[Keys@test4Data3kr2C19, {"TopProbabilities", 2}]]
```

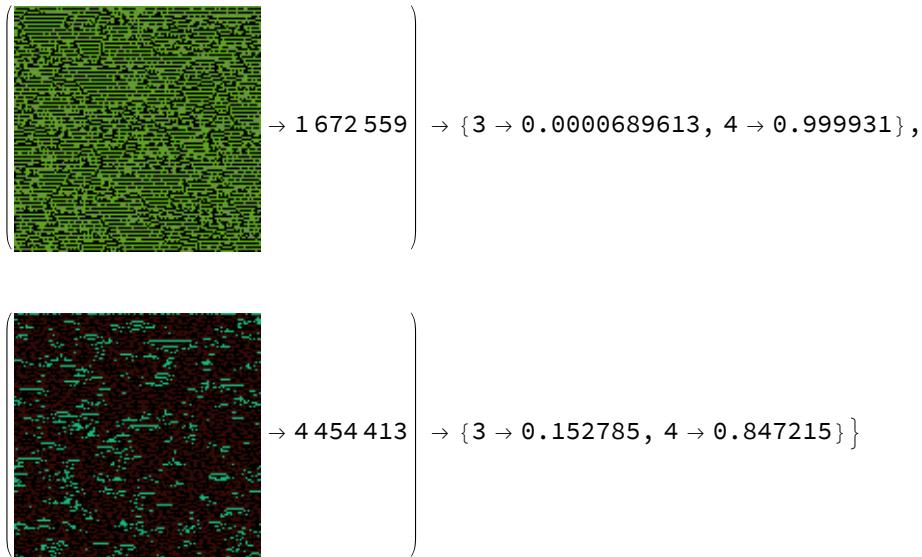




3-colour totalistic, range 3

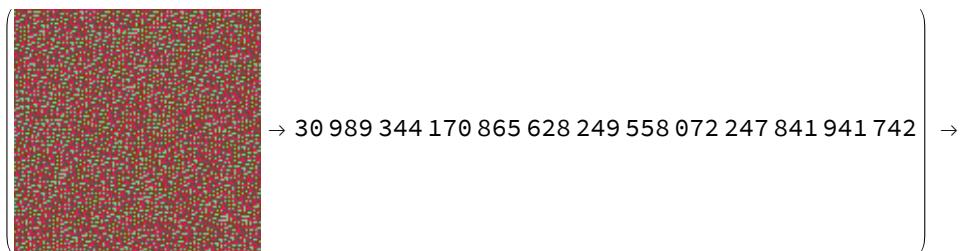
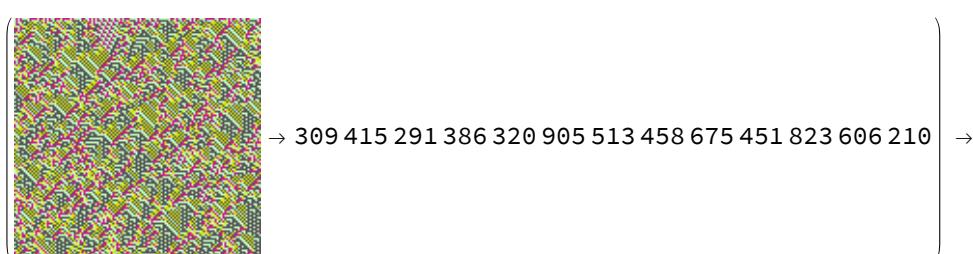
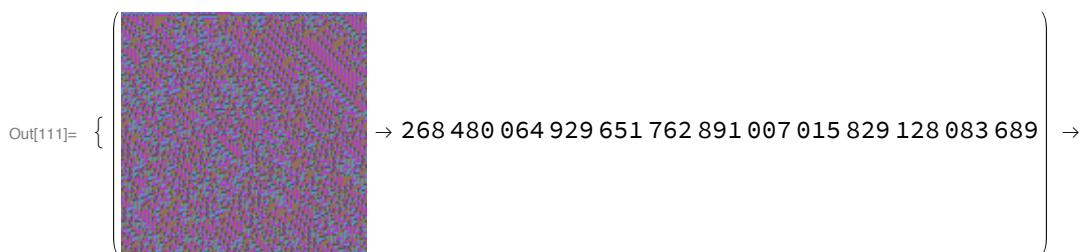
```
In[104]:= test4Data3kr3C19 = datak3r3C[128, 128, 8];
Thread[
  test4Data3kr3C19 → netECA19[Keys@test4Data3kr3C19, {"TopProbabilities", 2}]]
```

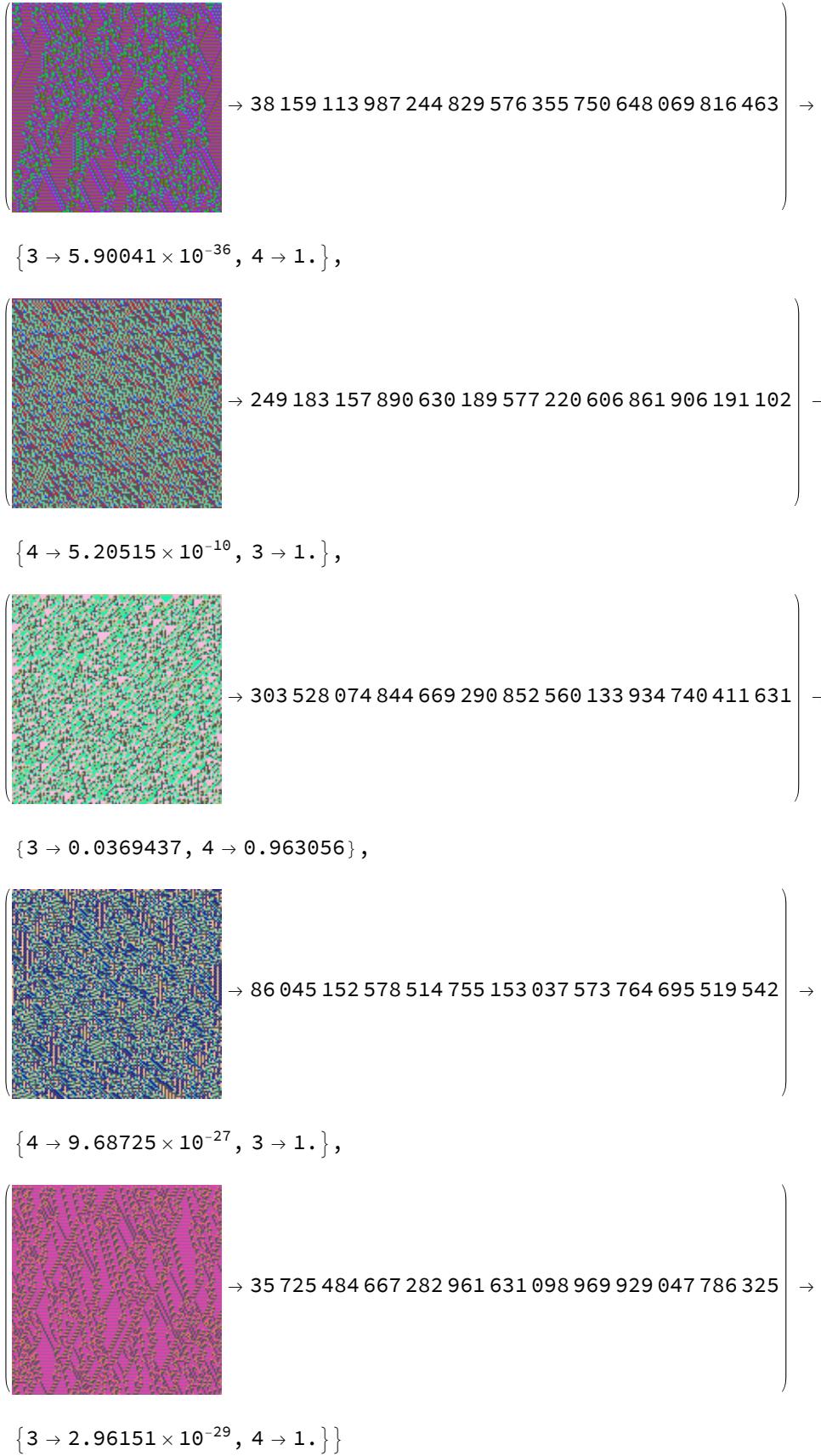
Out[105]=	{		→ 5 332 402	}	→ {1 → 0., 3 → 1.},
			→ 12 215 348	}	→ {3 → 0.0215091, 4 → 0.978491},
			→ 5 882 266	}	→ {4 → 7.74599 × 10⁻¹⁰, 3 → 1.},
			→ 3 262 519	}	→ {1 → 0., 3 → 1.},
			→ 4 981 094	}	→ {4 → 0.000228014, 3 → 0.999772},
			→ 9 082 439	}	→ {4 → 1.88074 × 10⁻¹³, 3 → 1.},



4-colour non-totalistic, range 1

```
In[110]:= test4Data4kr1C19 = datak4r1NT[128, 128, 8];
Thread[
  test4Data4kr1C19 &gt;> netECA19[Keys@test4Data4kr1C19, {"TopProbabilities", 2}]]
```





4-colour totalistic, range 2

```
In[112]:= test4Data4kr2C19 = data4r2C[128, 128, 8];
Thread[
  test4Data4kr2C19 → netECA19[Keys@test4Data4kr2C19, {"TopProbabilities", 2}]]
```

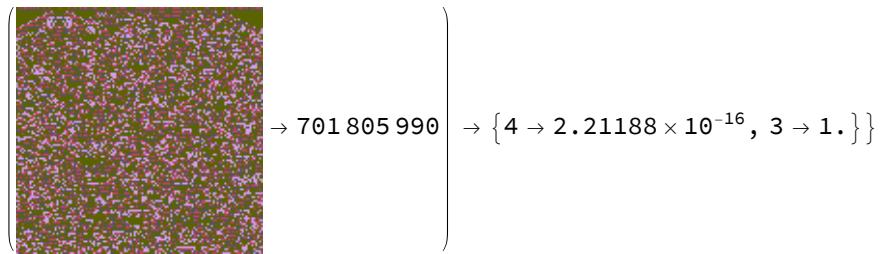
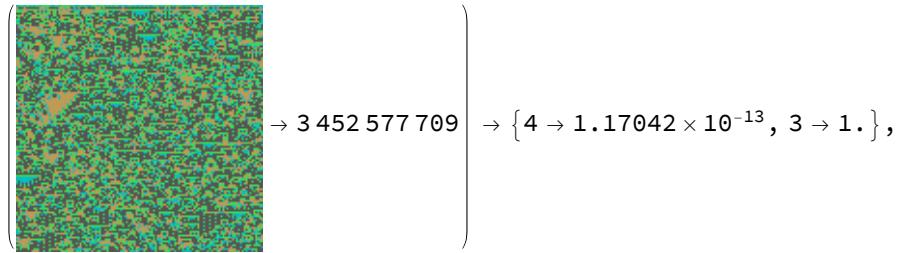
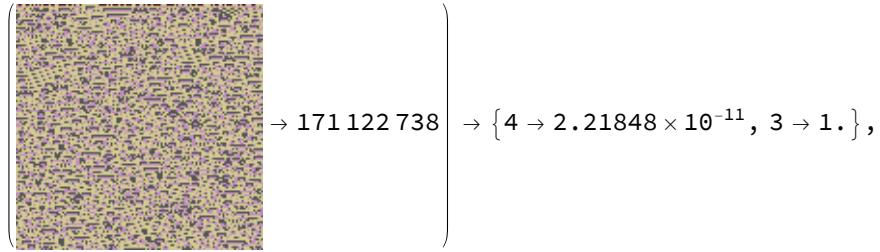
Out[113]= $\left\{ \begin{array}{c} \text{(A 128x128 red noisy image)} \\ \rightarrow 3\ 039\ 279\ 908 \end{array} \right\} \rightarrow \{4 \rightarrow 1.99769 \times 10^{-22}, 3 \rightarrow 1.\},$

Out[113]= $\left\{ \begin{array}{c} \text{(A 128x128 green noisy image)} \\ \rightarrow 1\ 004\ 857\ 722 \end{array} \right\} \rightarrow \{4 \rightarrow 2.69276 \times 10^{-14}, 3 \rightarrow 1.\},$

Out[113]= $\left\{ \begin{array}{c} \text{(A 128x128 yellow noisy image)} \\ \rightarrow 1\ 136\ 086\ 050 \end{array} \right\} \rightarrow \{4 \rightarrow 5.1036 \times 10^{-14}, 3 \rightarrow 1.\},$

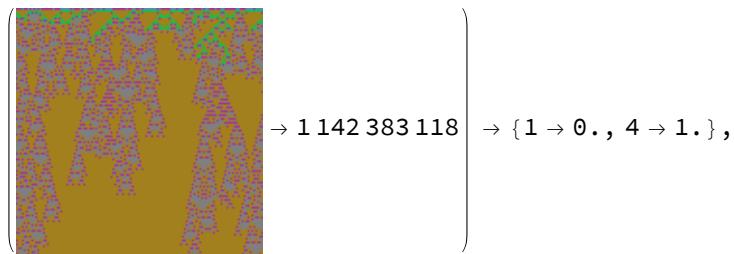
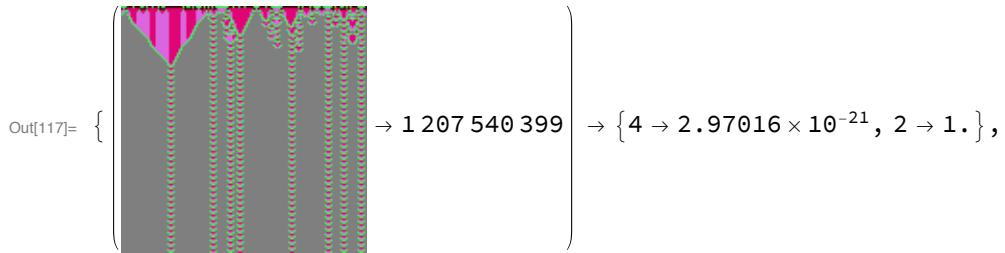
Out[113]= $\left\{ \begin{array}{c} \text{(A 128x128 black and white triangular pattern)} \\ \rightarrow 3\ 492\ 358\ 882 \end{array} \right\} \rightarrow \{3 \rightarrow 1.56014 \times 10^{-7}, 4 \rightarrow 1.\},$

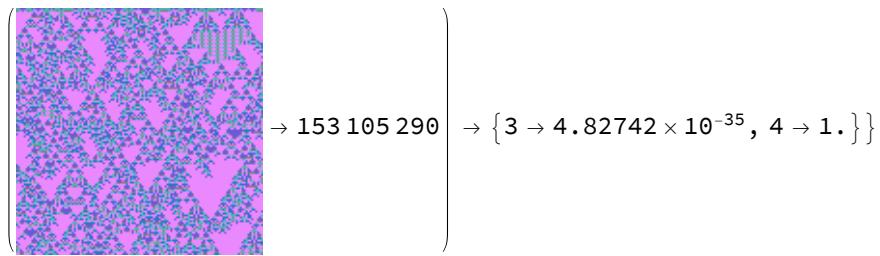
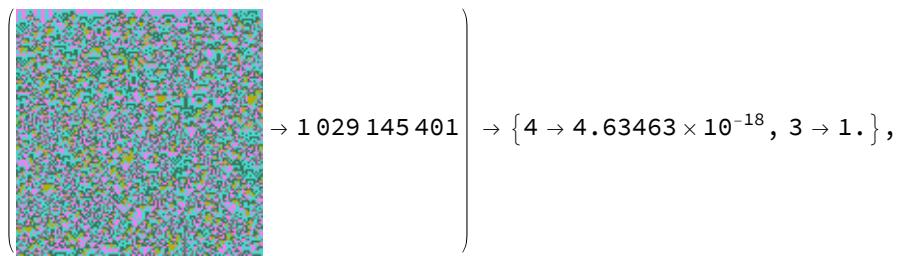
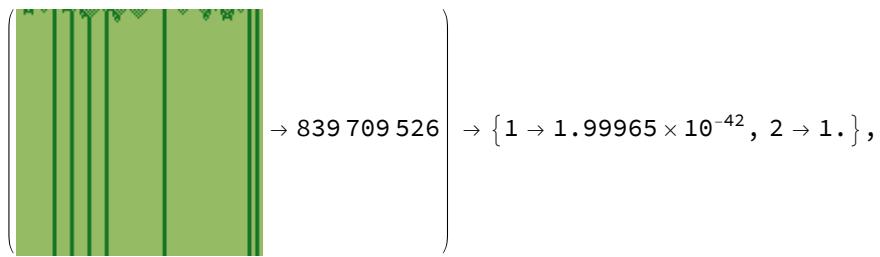
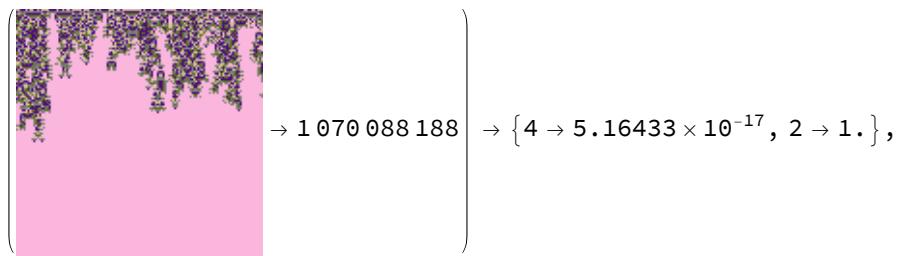
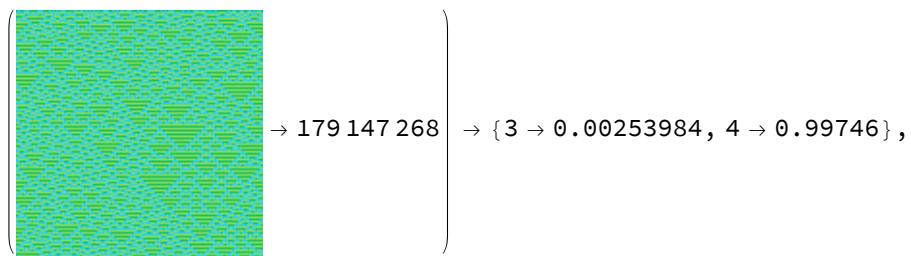
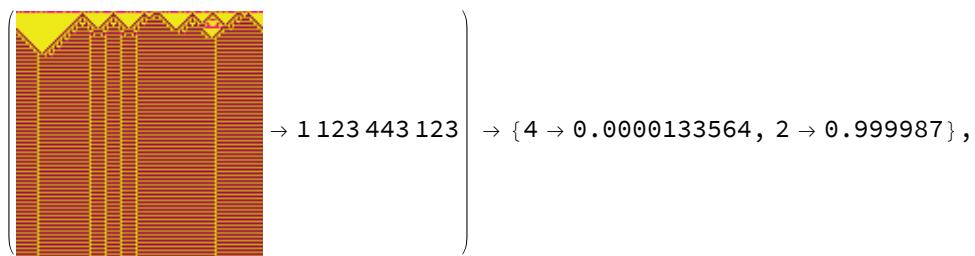
Out[113]= $\left\{ \begin{array}{c} \text{(A 128x128 blue noisy image)} \\ \rightarrow 1\ 069\ 866\ 717 \end{array} \right\} \rightarrow \{4 \rightarrow 8.91689 \times 10^{-21}, 3 \rightarrow 1.\},$



5-colour totalistic, range 1

```
In[116]:= test4Data5kr1C19 = data5T2C[8, 128, 128];
Thread[
  test4Data5kr1C19 → netECA19[Keys@test4Data5kr1C19, {"TopProbabilities", 2}]]
```





6-colour totalistic, range 1

```
In[124]:= test4Data6kr1C19 = data6TC[8, 128, 128];
Thread[
  test4Data6kr1C19 → netECA19[Keys@test4Data6kr1C19, {"TopProbabilities", 2}]]
```

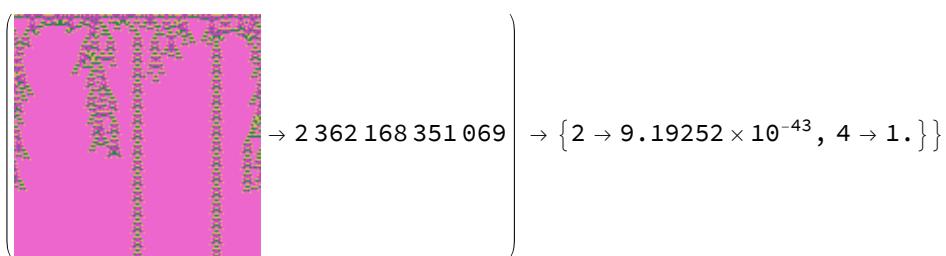
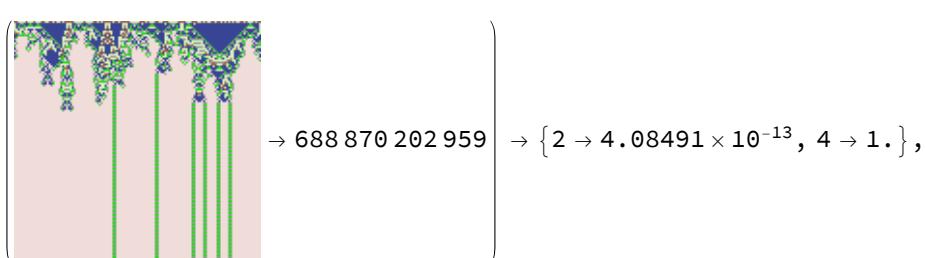
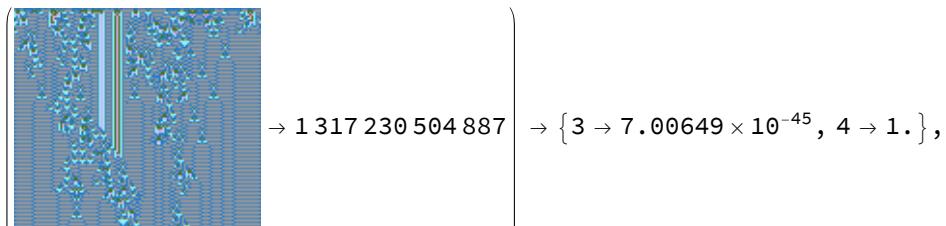
$$\text{Out}[125]= \left\{ \begin{array}{c} \text{[A 128x128 grid of 6 colors]} \\ \rightarrow 521\ 151\ 757\ 166 \end{array} \right\} \rightarrow \{4 \rightarrow 4.2538 \times 10^{-27}, 3 \rightarrow 1.\},$$

$$\left\{ \begin{array}{c} \text{[A 128x128 grid of 6 colors]} \\ \rightarrow 1\ 148\ 948\ 615\ 051 \end{array} \right\} \rightarrow \{3 \rightarrow 1.05684 \times 10^{-11}, 4 \rightarrow 1.\},$$

$$\left\{ \begin{array}{c} \text{[A 128x128 grid of 6 colors]} \\ \rightarrow 1\ 701\ 138\ 861\ 521 \end{array} \right\} \rightarrow \{3 \rightarrow 0.344279, 4 \rightarrow 0.655721\},$$

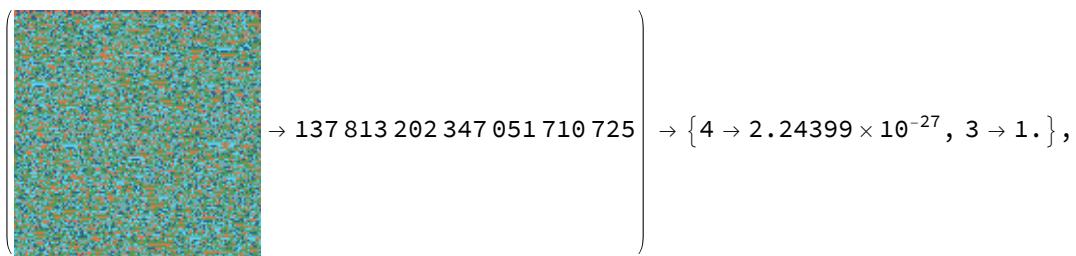
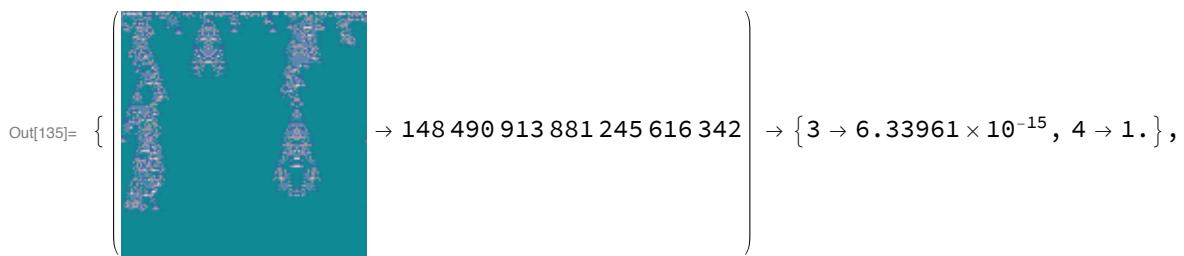
$$\left\{ \begin{array}{c} \text{[A 128x128 grid of 6 colors]} \\ \rightarrow 772\ 044\ 852\ 372 \end{array} \right\} \rightarrow \{4 \rightarrow 3.00861 \times 10^{-22}, 2 \rightarrow 1.\},$$

$$\left\{ \begin{array}{c} \text{[A 128x128 grid of 6 colors]} \\ \rightarrow 401\ 641\ 356\ 701 \end{array} \right\} \rightarrow \{4 \rightarrow 1.64612 \times 10^{-16}, 3 \rightarrow 1.\},$$



6-colour totalistic, range 2

```
In[134]:= test4Data6kr2C19 = data6T2C[8, 128, 128];
Thread[
  test4Data6kr2C19 → netECA19[Keys@test4Data6kr2C19, {"TopProbabilities", 2}]]
```



$$\left(\begin{array}{c} \text{[A 4x4 grid of random colors]} \\ \rightarrow 145\ 612\ 570\ 579\ 789\ 266\ 485 \end{array} \right) \rightarrow \{4 \rightarrow 1.52405 \times 10^{-9}, 3 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 4x4 grid of random colors]} \\ \rightarrow 57\ 362\ 919\ 586\ 594\ 306\ 710 \end{array} \right) \rightarrow \{4 \rightarrow 0.031388, 3 \rightarrow 0.968612\},$$

$$\left(\begin{array}{c} \text{[A 4x4 grid of random colors]} \\ \rightarrow 24\ 770\ 952\ 214\ 224\ 040\ 296 \end{array} \right) \rightarrow \{4 \rightarrow 5.16516 \times 10^{-16}, 3 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 4x4 grid of random colors]} \\ \rightarrow 143\ 600\ 862\ 017\ 240\ 236\ 453 \end{array} \right) \rightarrow \{4 \rightarrow 1.30214 \times 10^{-22}, 3 \rightarrow 1.\},$$

$$\left(\begin{array}{c} \text{[A 4x4 grid of random colors]} \\ \rightarrow 160\ 410\ 817\ 633\ 450\ 677\ 074 \end{array} \right) \rightarrow \{4 \rightarrow 0.000231853, 3 \rightarrow 0.999768\},$$

$$\left(\begin{array}{c} \text{[A 4x4 grid of random colors]} \\ \rightarrow 99\ 035\ 735\ 849\ 117\ 353\ 433 \end{array} \right) \rightarrow \{4 \rightarrow 7.72208 \times 10^{-20}, 3 \rightarrow 1.\}$$

7-colour totalistic, range 1

```
In[140]:= test4Data7kr1C19 = data7TC[8, 128, 128];
Thread[
  test4Data7kr1C19 → netECA19[Keys@test4Data7kr1C19, {"TopProbabilities", 2}]]
```

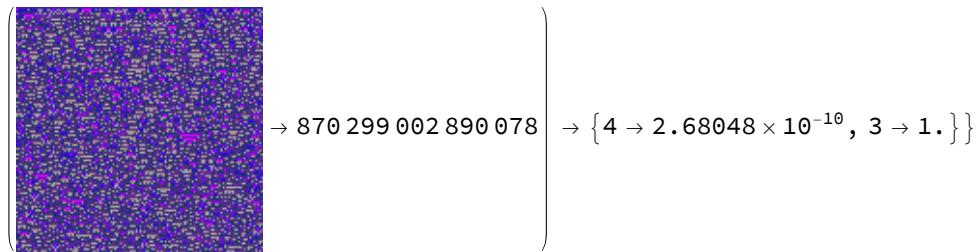
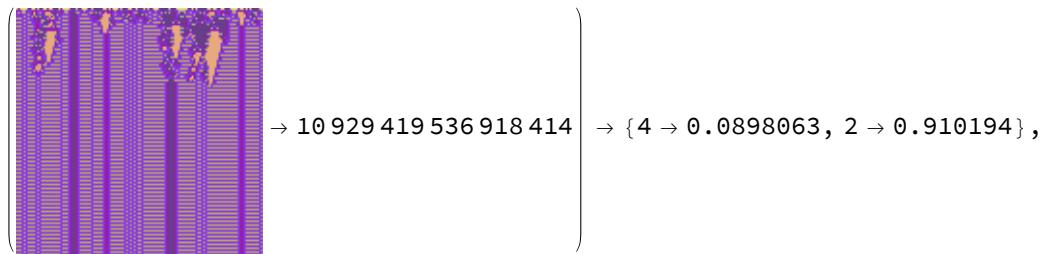
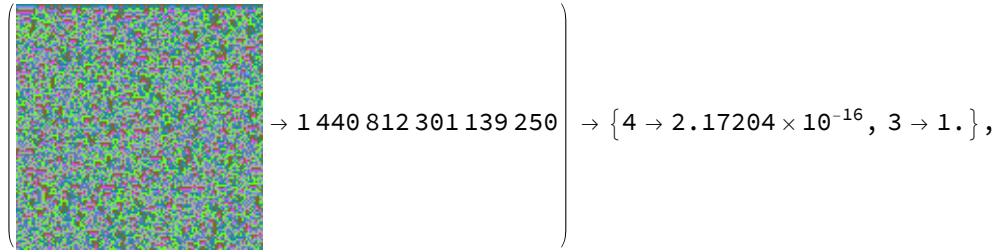
Out[141]= $\left\{ \begin{array}{c} \text{A 128x128 pixel image showing a pattern of green, blue, and red cells.} \\ \rightarrow 7905962486151833 \end{array} \right\} \rightarrow \{4 \rightarrow 0.000554173, 3 \rightarrow 0.999446\},$

$\left\{ \begin{array}{c} \text{A 128x128 pixel image showing a pattern of green, yellow, and grey cells.} \\ \rightarrow 5986825348569542 \end{array} \right\} \rightarrow \{4 \rightarrow 0.0000562114, 3 \rightarrow 0.999944\},$

$\left\{ \begin{array}{c} \text{A 128x128 pixel image showing a pattern of purple, blue, and red cells.} \\ \rightarrow 5160779372988604 \end{array} \right\} \rightarrow \{3 \rightarrow 1.30743 \times 10^{-8}, 4 \rightarrow 1.\},$

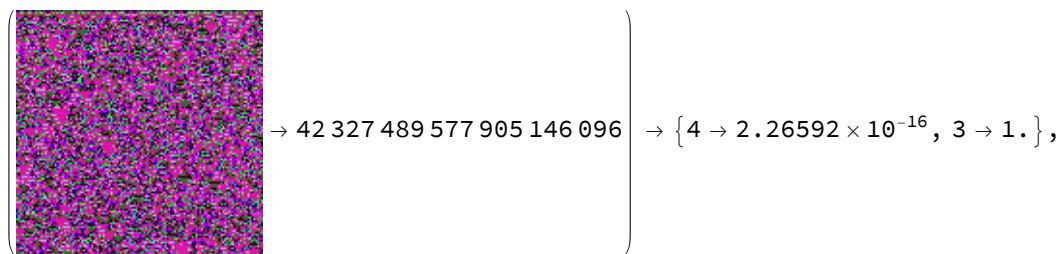
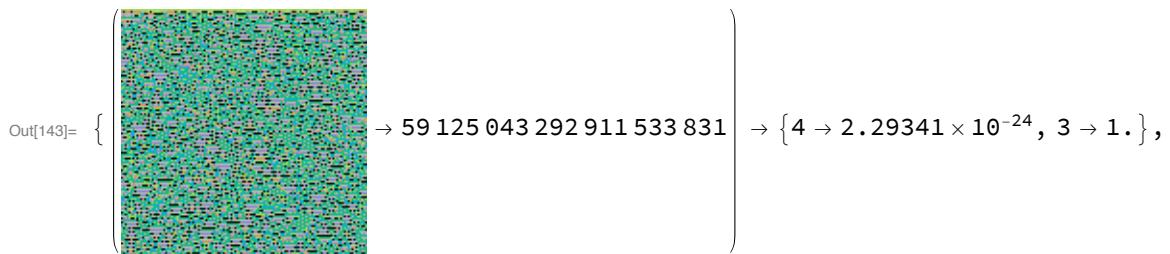
$\left\{ \begin{array}{c} \text{A 128x128 pixel image showing a pattern of yellow, red, and green cells.} \\ \rightarrow 2668104076298035 \end{array} \right\} \rightarrow \{4 \rightarrow 3.94844 \times 10^{-18}, 3 \rightarrow 1.\},$

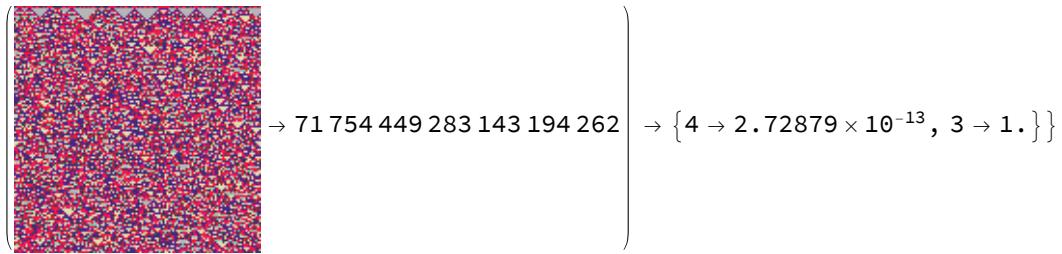
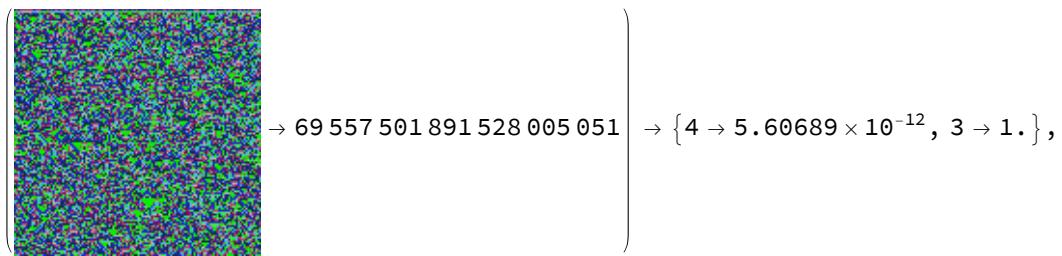
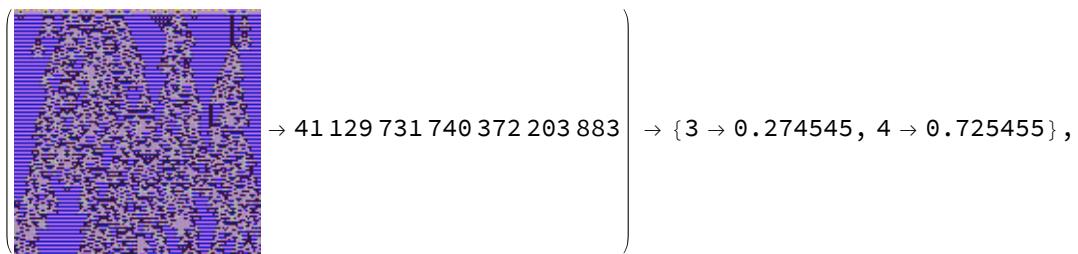
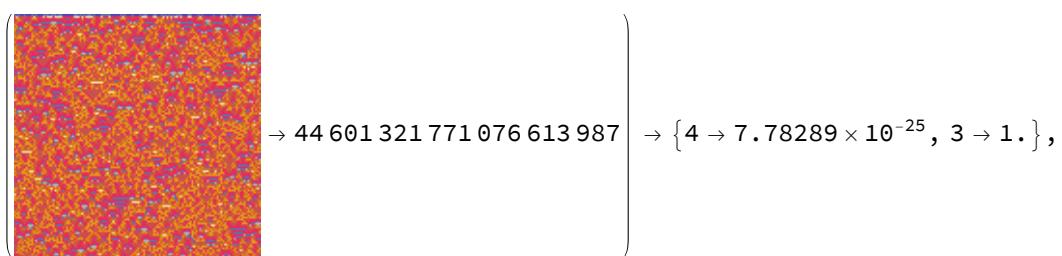
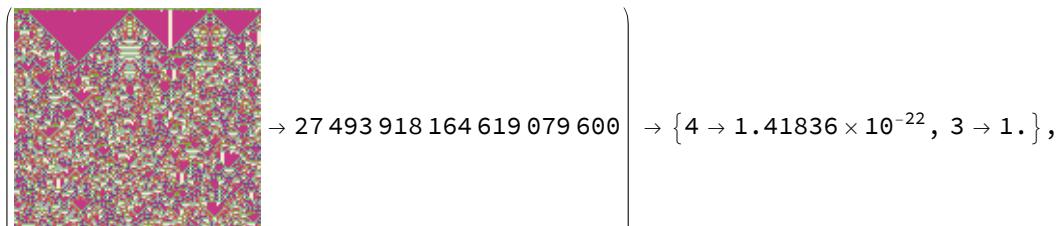
$\left\{ \begin{array}{c} \text{A 128x128 pixel image showing a pattern of red, green, and blue cells.} \\ \rightarrow 3691759700407743 \end{array} \right\} \rightarrow \{4 \rightarrow 4.45377 \times 10^{-16}, 3 \rightarrow 1.\},$



8-colour totalistic, range 1

```
In[142]:= test4Data8kr1C19 = data8TC[8, 128, 128];
Thread[
  test4Data8kr1C19 → netECA19[Keys@test4Data8kr1C19, {"TopProbabilities", 2}]]
```





```
In[146]:= test4Data8kr1C19 = data8TC[8, 128, 128];
Thread[
  test4Data8kr1C19 → netECA19[Keys@test4Data8kr1C19, {"TopProbabilities", 2}]]
```

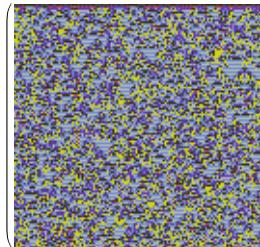
Out[147]= $\left\{ \begin{array}{c} \text{A 128x128 grayscale image showing a noisy pattern of black, white, and gray pixels.} \\ \rightarrow 30\ 958\ 781\ 818\ 328\ 214\ 442 \end{array} \right\} \rightarrow \left\{ 4 \rightarrow 4.62524 \times 10^{-15}, 3 \rightarrow 1. \right\},$

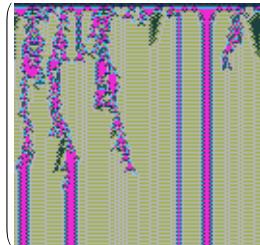
$\left\{ \begin{array}{c} \text{A 128x128 grayscale image showing a noisy pattern of black, white, and gray pixels.} \\ \rightarrow 61\ 018\ 914\ 870\ 782\ 867\ 384 \end{array} \right\} \rightarrow \left\{ 4 \rightarrow 1.13687 \times 10^{-12}, 3 \rightarrow 1. \right\},$

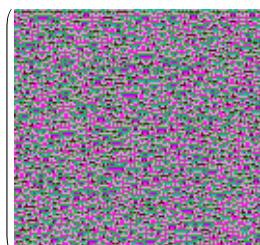
$\left\{ \begin{array}{c} \text{A 128x128 grayscale image showing a noisy pattern of black, white, and gray pixels.} \\ \rightarrow 20\ 705\ 257\ 985\ 378\ 094\ 677 \end{array} \right\} \rightarrow \left\{ 4 \rightarrow 1.82975 \times 10^{-19}, 3 \rightarrow 1. \right\},$

$\left\{ \begin{array}{c} \text{A 128x128 grayscale image showing a noisy pattern of black, white, and gray pixels.} \\ \rightarrow 43\ 941\ 374\ 463\ 684\ 638\ 030 \end{array} \right\} \rightarrow \left\{ 4 \rightarrow 1.04552 \times 10^{-6}, 3 \rightarrow 0.999999 \right\},$

$\left\{ \begin{array}{c} \text{A 128x128 grayscale image showing a noisy pattern of black, white, and gray pixels.} \\ \rightarrow 3\ 024\ 227\ 929\ 898\ 264\ 848 \end{array} \right\} \rightarrow \left\{ 4 \rightarrow 1.85219 \times 10^{-8}, 3 \rightarrow 1. \right\},$

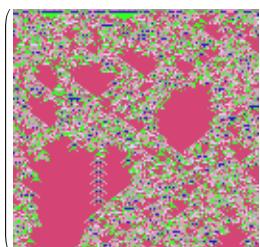
 → 17 487 862 603 567 426 913 } → { 4 → 3.05308×10^{-7} , 3 → 1. },

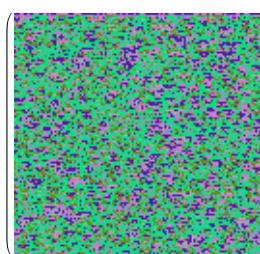
 → 63 093 631 381 744 169 828 } → { 2 → 1.26841×10^{-29} , 4 → 1. },

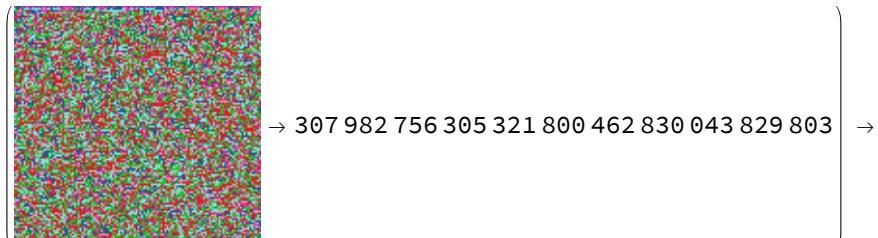
 → 27 830 330 837 012 619 129 } → { 4 → 0.126106, 3 → 0.873894 }

8-colour totalistic, range 2

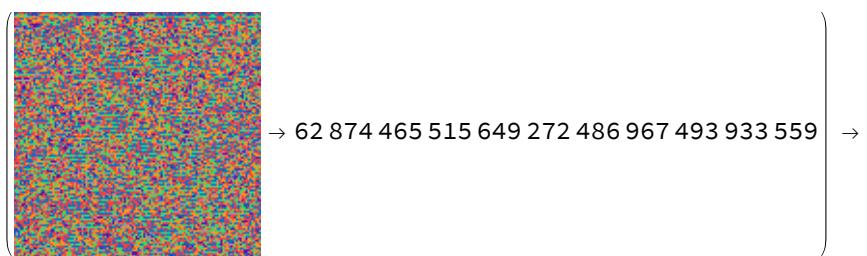
```
In[162]:= test4Data8kr2C19 = data8T2C[8, 128, 128];
Thread[
  test4Data8kr2C19 → netECA19[Keys@test4Data8kr2C19, {"TopProbabilities", 2}]]
```

Out[163]= {  → 147 951 460 881 093 444 119 820 865 699 524 } → { 3 → 1.95996×10^{-6} , 4 → 0.999998 },

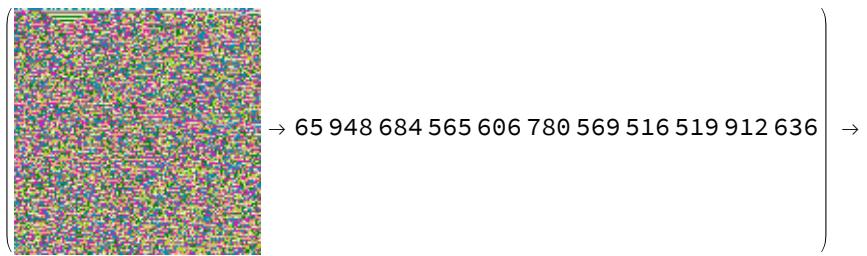
 → 119 355 423 761 325 445 881 228 685 558 134 } → { 4 → 0.060776, 3 → 0.939224 },



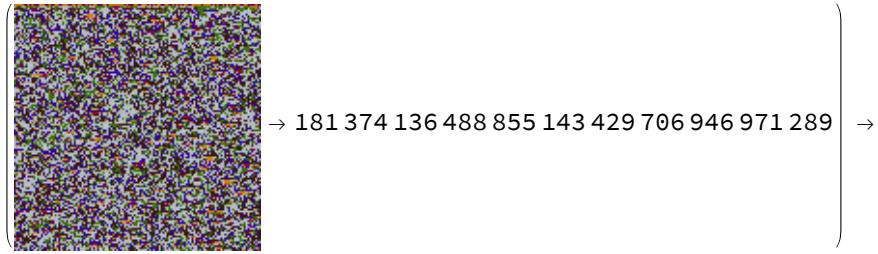
$\{ 4 \rightarrow 2.91468 \times 10^{-9}, 3 \rightarrow 1. \},$



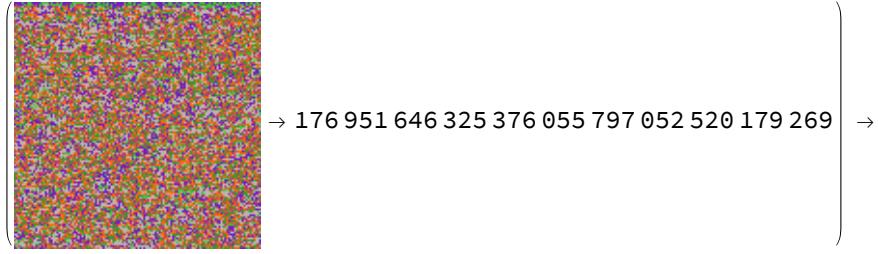
$\{ 4 \rightarrow 5.81908 \times 10^{-7}, 3 \rightarrow 0.999999 \},$



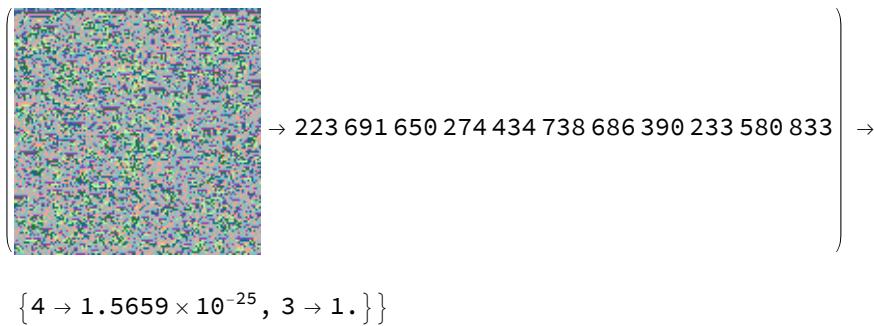
$\{ 4 \rightarrow 0.0000545016, 3 \rightarrow 0.999946 \},$



$\{ 4 \rightarrow 2.66552 \times 10^{-19}, 3 \rightarrow 1. \},$

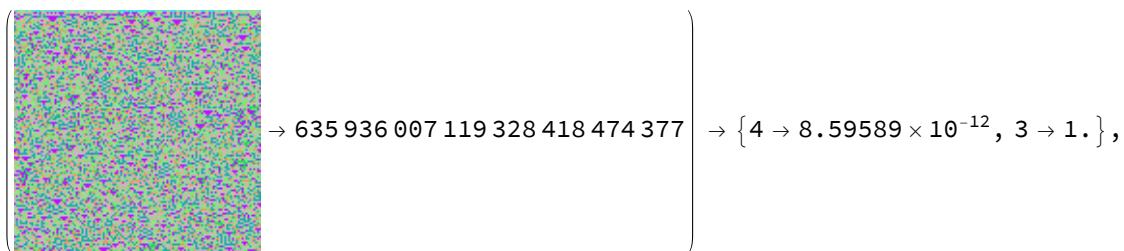
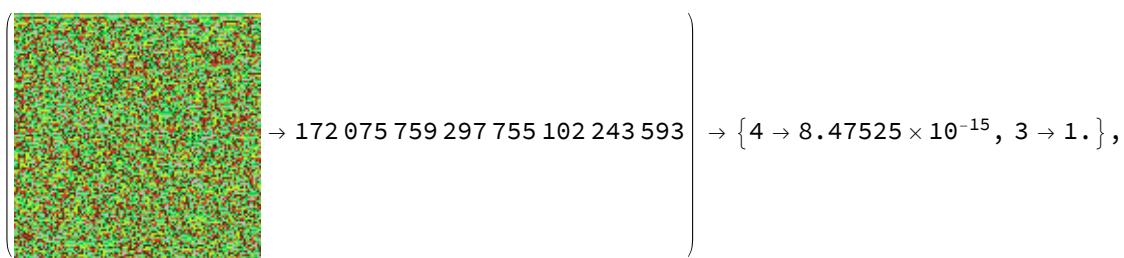
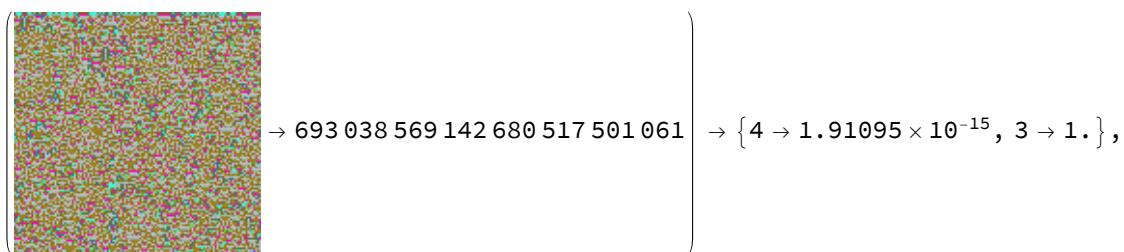
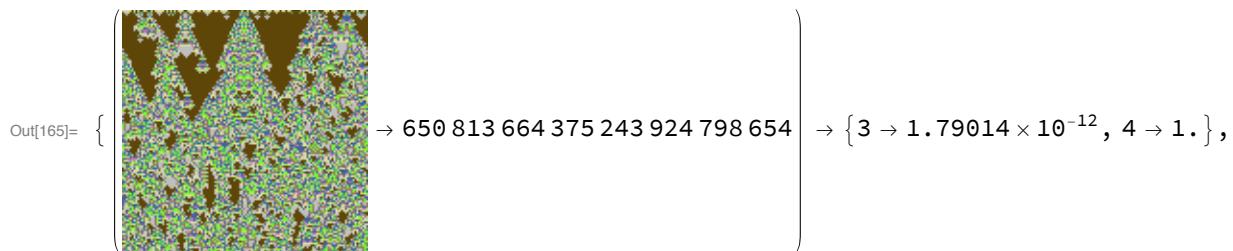


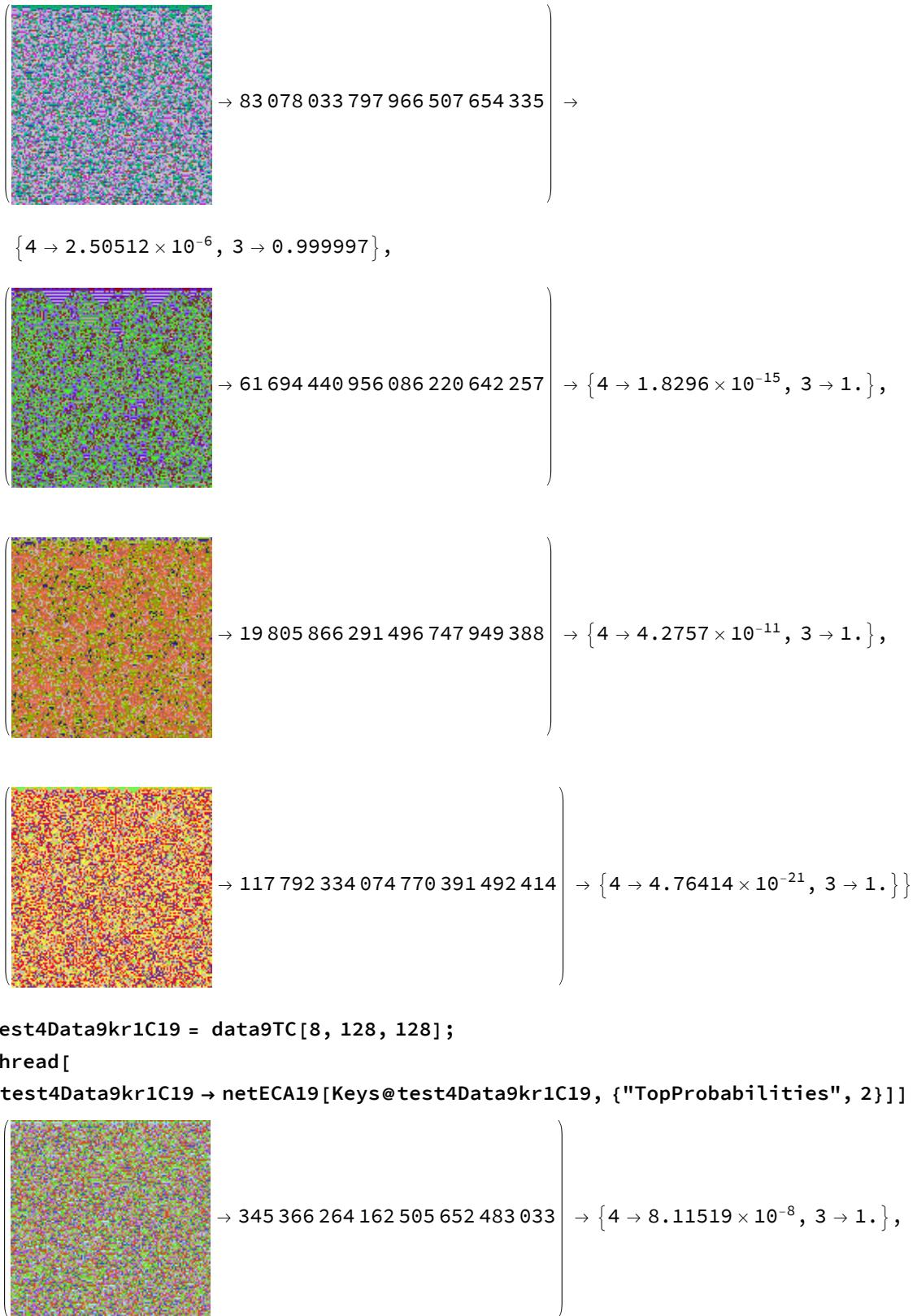
$\{ 4 \rightarrow 1.80483 \times 10^{-11}, 3 \rightarrow 1. \},$

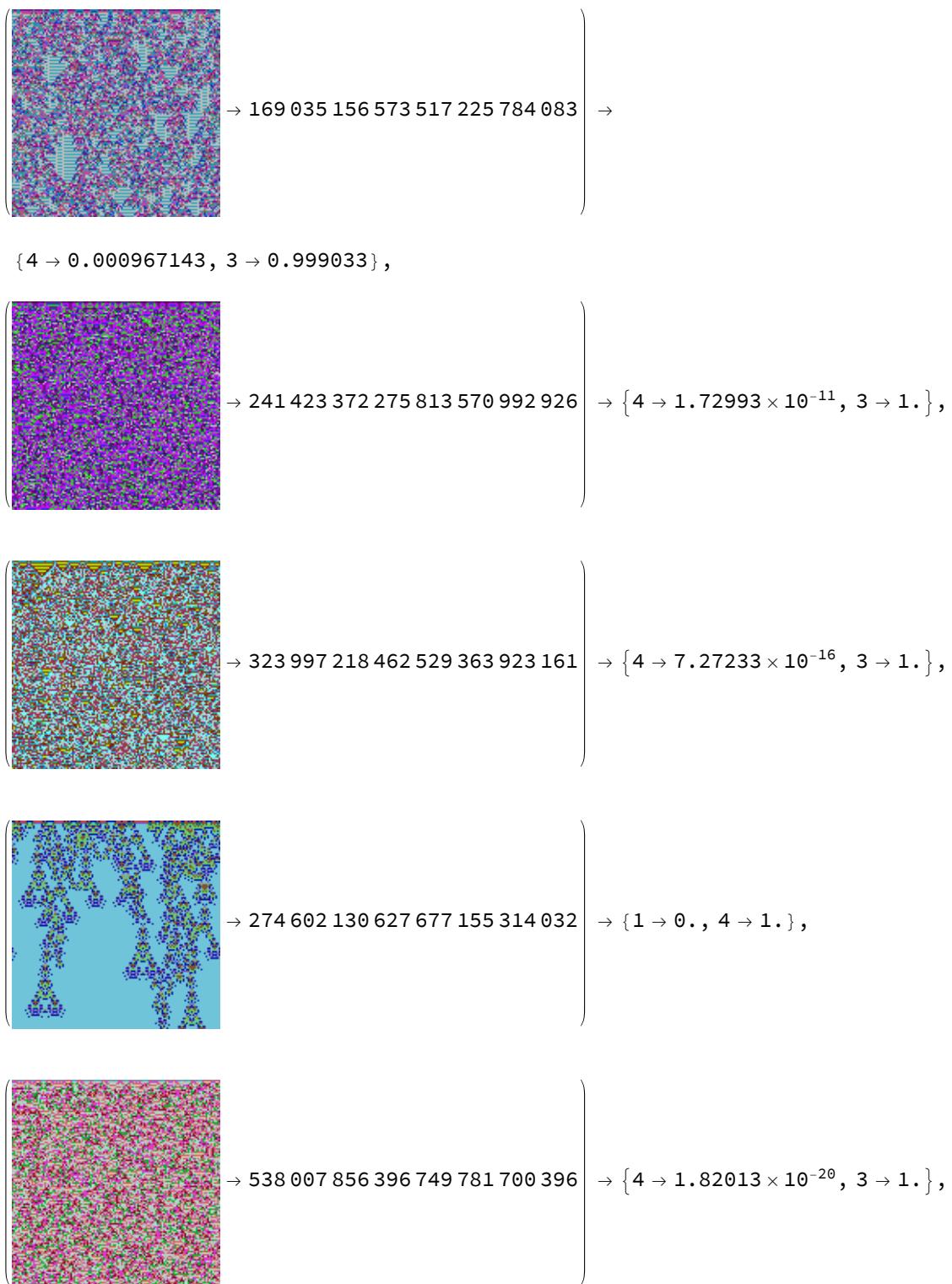


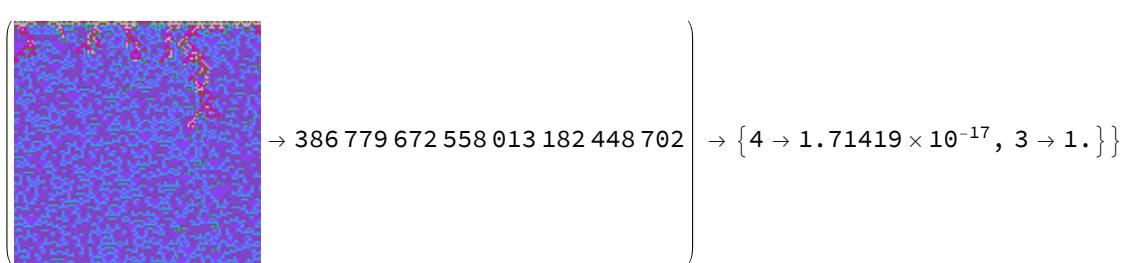
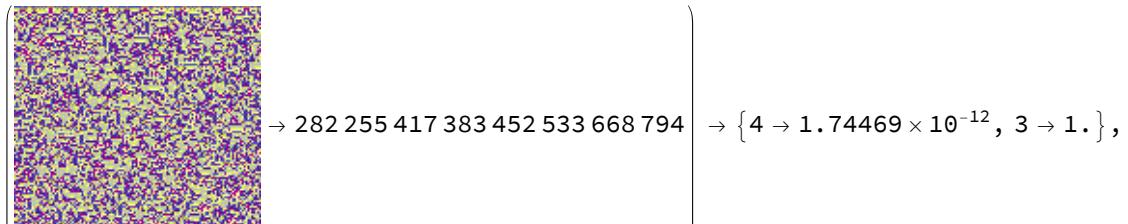
9-colour totalistic, range 1

```
In[164]:= test4Data9kr1C19 = data9TC[8, 128, 128];
Thread[
  test4Data9kr1C19 &gt;> netECA19[Keys@test4Data9kr1C19, {"TopProbabilities", 2}]]
```

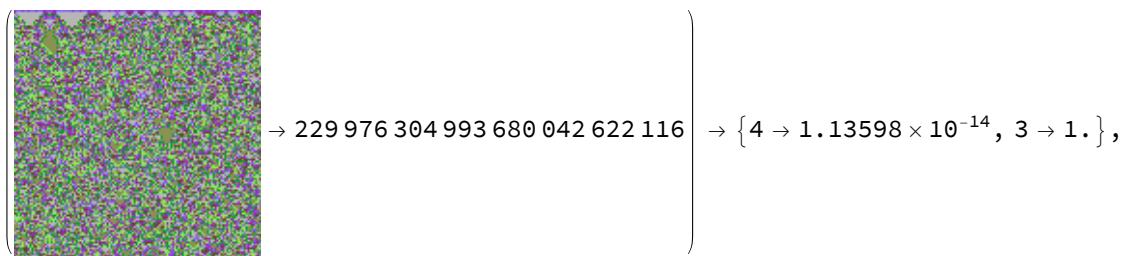
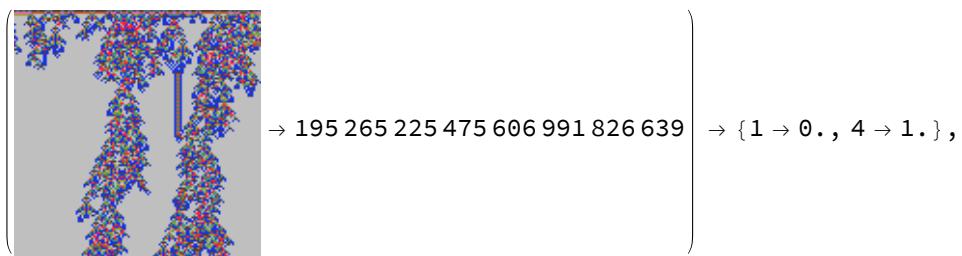
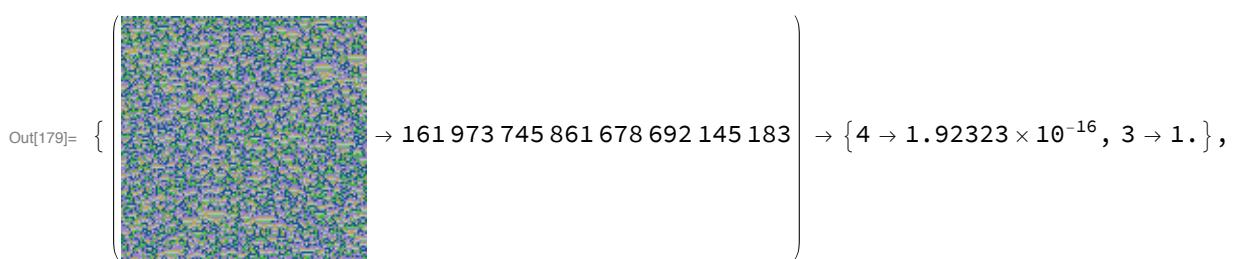


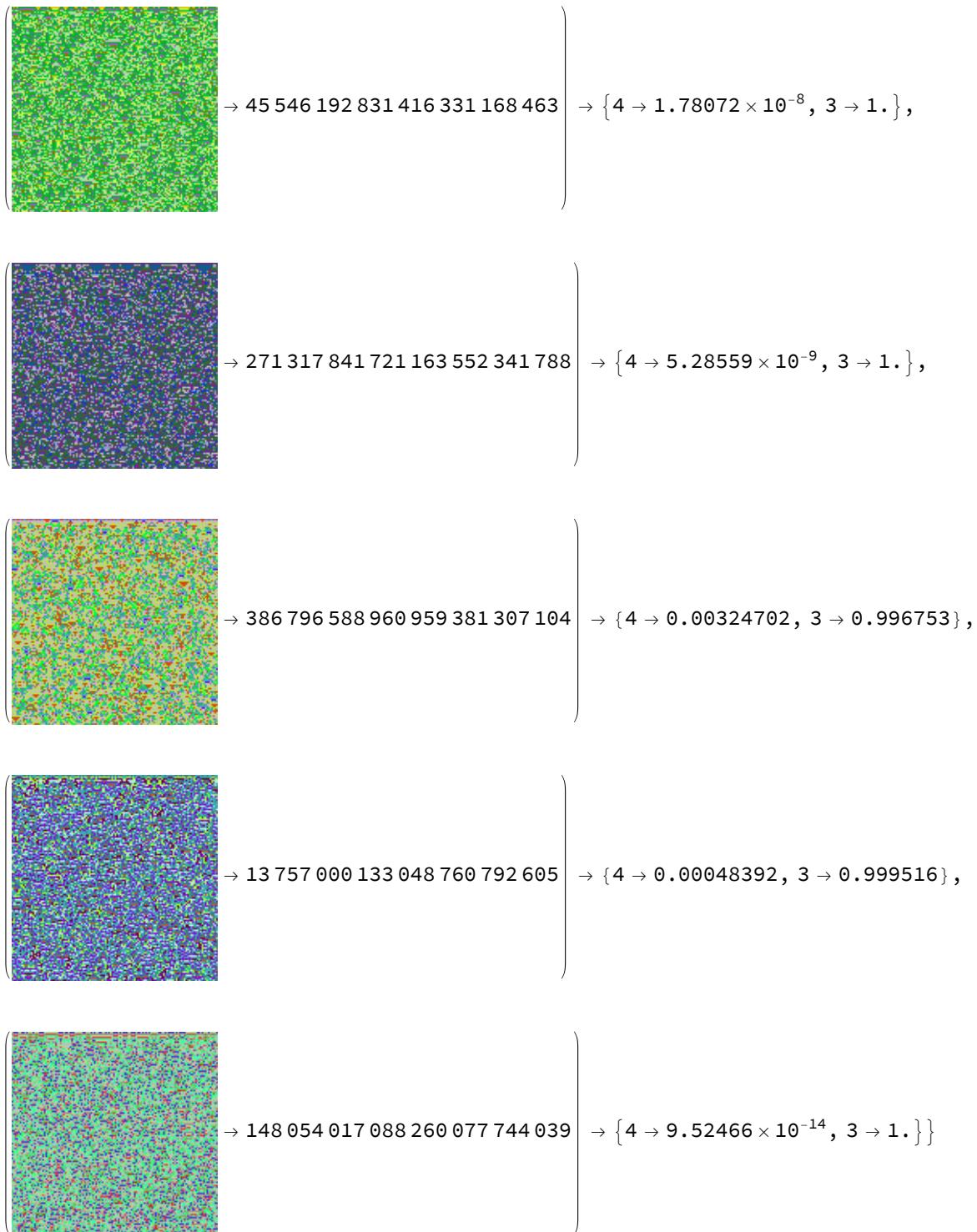






```
In[178]:= test4Data9kr1C19 = data9TC[8, 128, 128];
Thread[
test4Data9kr1C19 → netECA19[Keys@test4Data9kr1C19, {"TopProbabilities", 2}]]
```



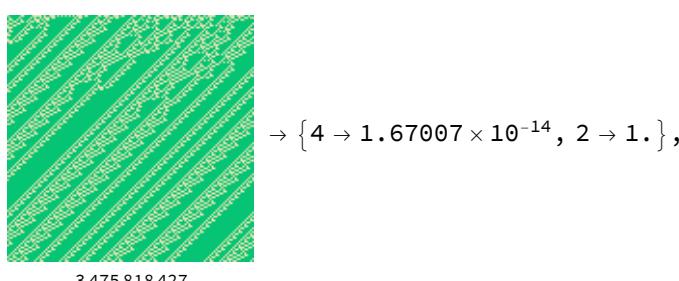
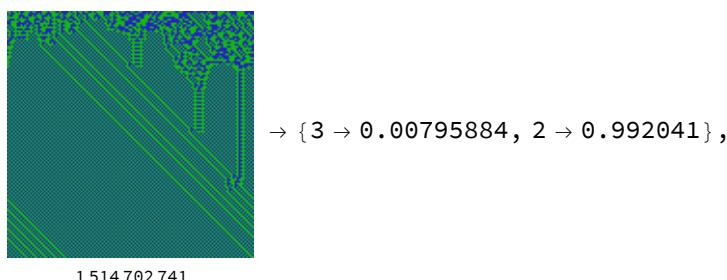
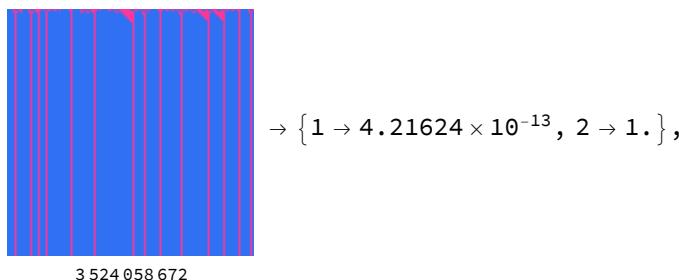
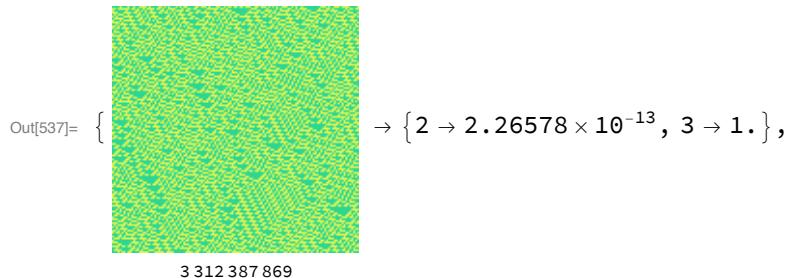


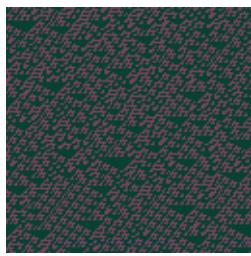
New Format for Unseen CA Testing

Testing Network XVIII (200 epochs) on unseen CA rule spaces - V2

2-colour non-totalistic, range 2

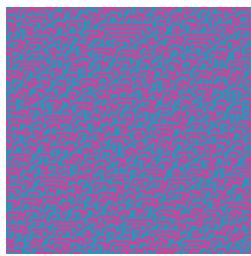
```
In[535]:= test4Data2kr2C18 = datak2r2C[128, 128, 8];
test4Data2kr2C18labeled = Thread[Labeled[
  Keys@test4Data2kr2C18, Values@test4Data2kr2C18, LabelStyle -> Small]];
Thread[test4Data2kr2C18labeled -> netECA18[Keys@test4Data2kr2C18,
 {"TopProbabilities", 2}]]
```





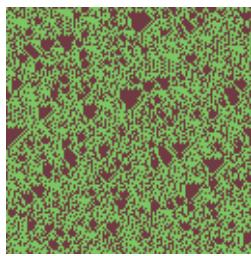
$$\rightarrow \{4 \rightarrow 1.01054 \times 10^{-21}, 3 \rightarrow 1.\},$$

1 083 655 580



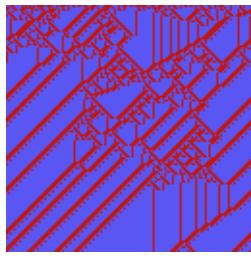
$$\rightarrow \{4 \rightarrow 3.28444 \times 10^{-8}, 3 \rightarrow 1.\},$$

1 874 576 323



$$\rightarrow \{4 \rightarrow 2.23374 \times 10^{-7}, 3 \rightarrow 1.\},$$

3 605 674 388

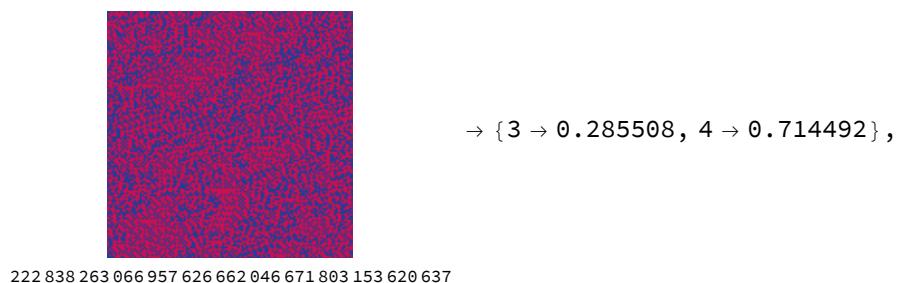
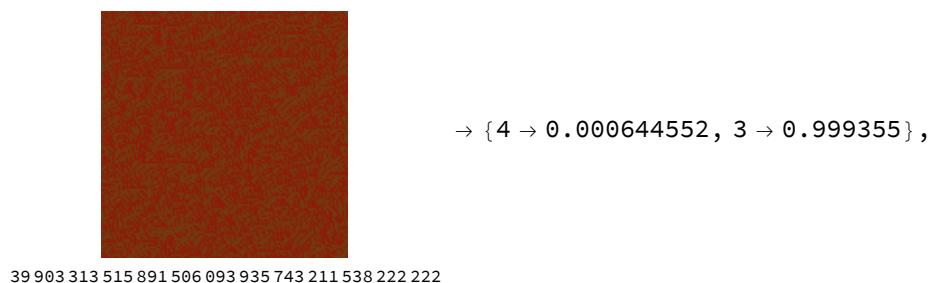
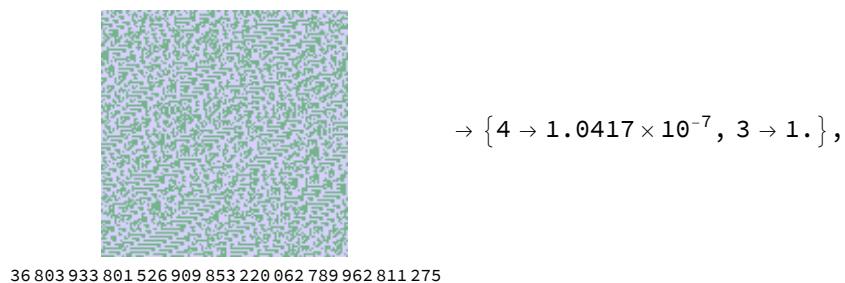
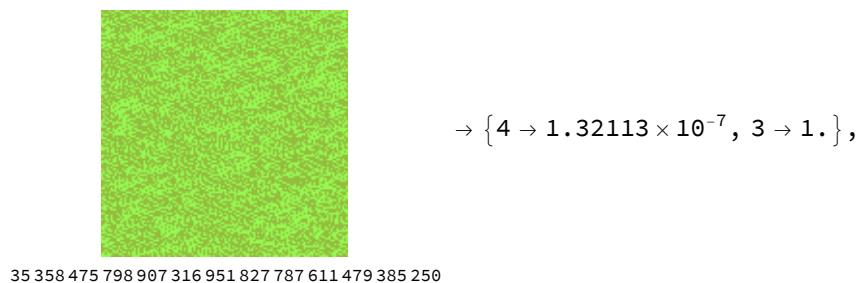
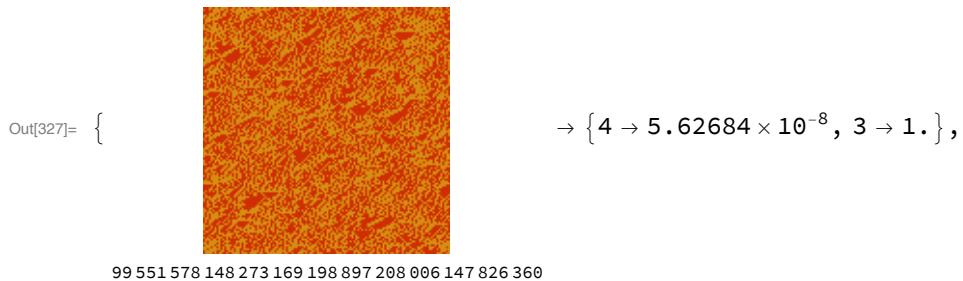


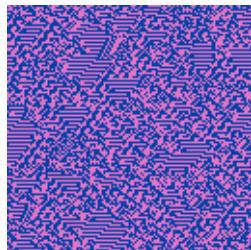
$$\rightarrow \{3 \rightarrow 2.80205 \times 10^{-10}, 4 \rightarrow 1.\}\}$$

1 126 749 880

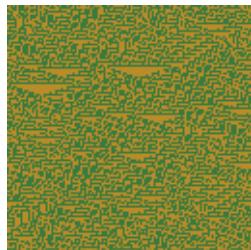
2-colour non-totalistic, range 3

```
In[325]:= test4Data2kr3C18 = datak2r3NT[128, 128, 8];
test4Data2kr3C18labeled = Thread[Labeled[
  Keys@test4Data2kr3C18, Values@test4Data2kr3C18, LabelStyle -> Small]];
Thread[test4Data2kr3C18labeled -> netECA18[Keys@test4Data2kr3C18,
 {"TopProbabilities", 2}]]
```

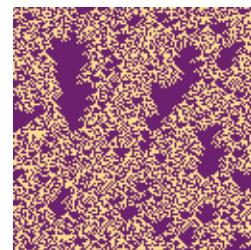



 $\rightarrow \{4 \rightarrow 1.83681 \times 10^{-10}, 3 \rightarrow 1.\},$

12 468 494 678 383 889 361 821 753 917 325 448 539


 $\rightarrow \{4 \rightarrow 1.0842 \times 10^{-19}, 3 \rightarrow 1.\},$

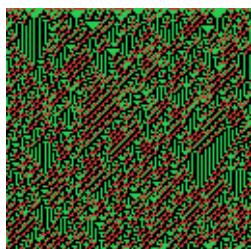
44 305 856 055 937 701 345 862 540 328 298 186 550


 $\rightarrow \{3 \rightarrow 9.105 \times 10^{-6}, 4 \rightarrow 0.999991\}\}$

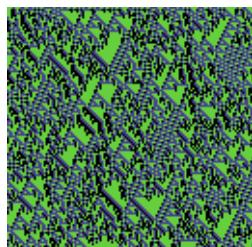
267 617 510 768 053 109 256 323 006 038 446 324 056

3-colour non-totalistic, range 1

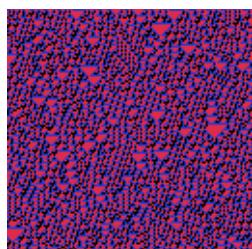
```
In[331]:= test4Data3kr1C18 = datak3r1NT[128, 128, 8];
test4Data3kr1C18labeled = Thread[Labeled[
  Keys@test4Data3kr1C18, Values@test4Data3kr1C18, LabelStyle -> Small]];
Thread[test4Data3kr1C18labeled -> netECA18[Keys@test4Data3kr1C18,
  {"TopProbabilities", 2}]]
```


 $\rightarrow \{3 \rightarrow 0.0917874, 4 \rightarrow 0.908213\},$

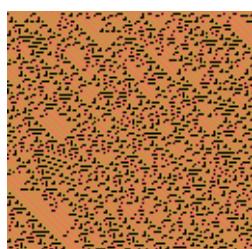
Out[333]= {1 571 302 467 213}


$$\rightarrow \{3 \rightarrow 4.22647 \times 10^{-10}, 4 \rightarrow 1.\},$$

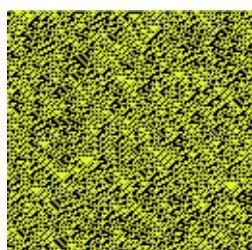
3 341 423 193 643


$$\rightarrow \{4 \rightarrow 1.09209 \times 10^{-6}, 3 \rightarrow 0.999999\},$$

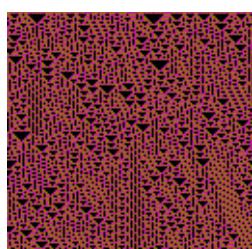
6 038 131 516 158


$$\rightarrow \{4 \rightarrow 0.0019874, 3 \rightarrow 0.998013\},$$

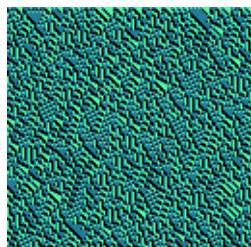
2 964 330 506 711


$$\rightarrow \{4 \rightarrow 0.149341, 3 \rightarrow 0.850659\},$$

2 043 795 596 664

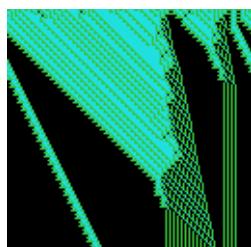

$$\rightarrow \{4 \rightarrow 4.64997 \times 10^{-15}, 3 \rightarrow 1.\},$$

6 229 038 683 407



$\rightarrow \{4 \rightarrow 1.23256 \times 10^{-6}, 3 \rightarrow 0.999999\},$

2 323 009 082 805

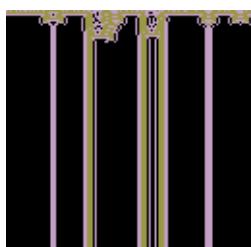


$\rightarrow \{2 \rightarrow 5.05033 \times 10^{-6}, 4 \rightarrow 0.999995\}\}$

7 237 003 779 873

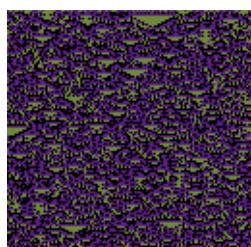
3-colour totalistic, range 2

```
In[334]:= test4Data3kr2C18 = datak3r2C[128, 128, 8];
test4Data3kr2C18labeled = Thread[Labeled[
  Keys@test4Data3kr2C18, Values@test4Data3kr2C18, LabelStyle -> Small]];
Thread[test4Data3kr2C18labeled -> netECA18[Keys@test4Data3kr2C18,
  {"TopProbabilities", 2}]]
```



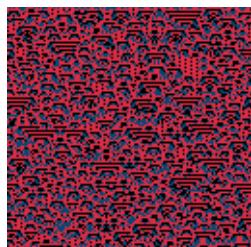
$\rightarrow \{4 \rightarrow 3.78844 \times 10^{-13}, 2 \rightarrow 1.\},$

174 070



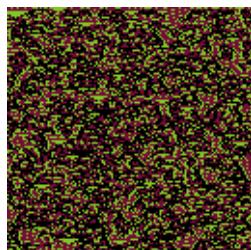
$\rightarrow \{4 \rightarrow 4.95807 \times 10^{-12}, 3 \rightarrow 1.\},$

108 828



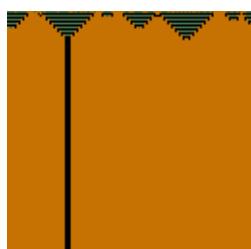
27 791

$$\rightarrow \{4 \rightarrow 7.17529 \times 10^{-14}, 3 \rightarrow 1.\},$$



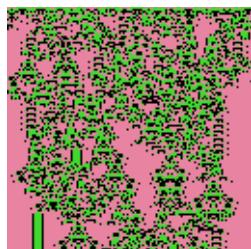
130 620

$$\rightarrow \{4 \rightarrow 3.4037 \times 10^{-10}, 3 \rightarrow 1.\},$$



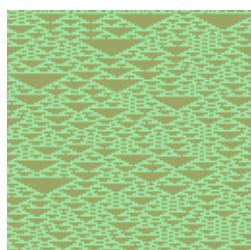
36 125

$$\rightarrow \{1 \rightarrow 2.30518 \times 10^{-32}, 2 \rightarrow 1.\},$$



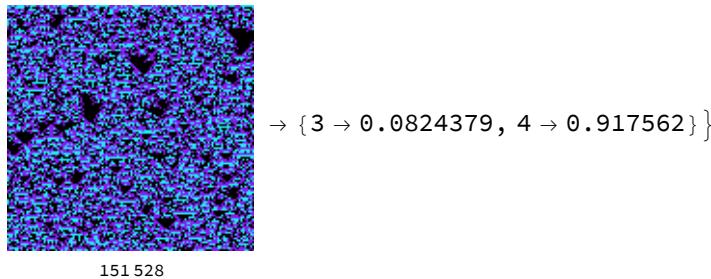
92 996

$$\rightarrow \{3 \rightarrow 1.06918 \times 10^{-9}, 4 \rightarrow 1.\},$$



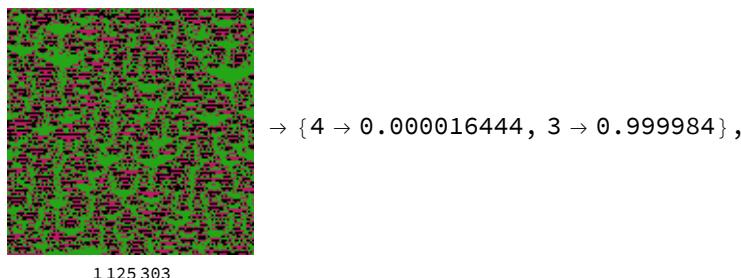
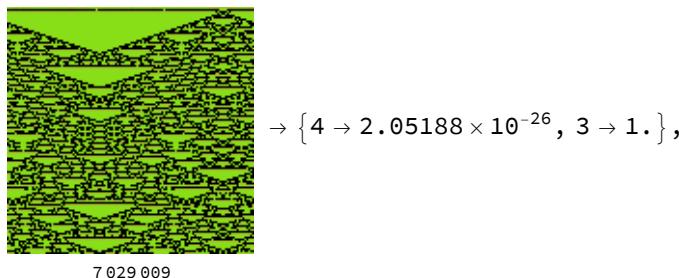
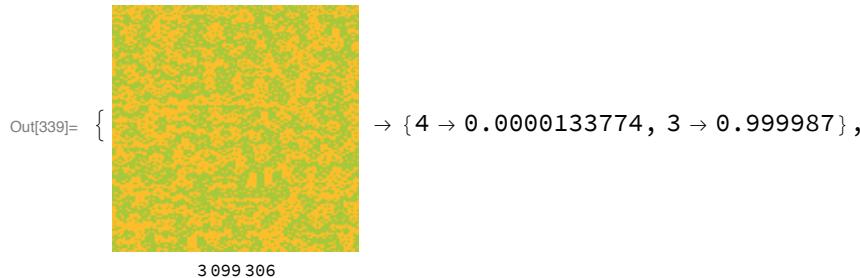
121 053

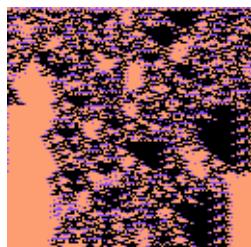
$$\rightarrow \{4 \rightarrow 9.93266 \times 10^{-17}, 3 \rightarrow 1.\},$$



3-colour totalistic, range 3

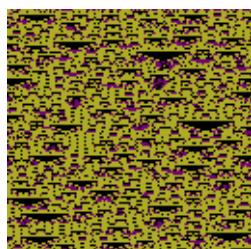
```
In[337]:= test4Data3kr3C18 = datak3r3C[128, 128, 8];
test4Data3kr3C18labeled = Thread[Labeled[
  Keys@test4Data3kr3C18, Values@test4Data3kr3C18, LabelStyle -> Small]];
Thread[test4Data3kr3C18labeled -> netECA18[Keys@test4Data3kr3C18,
 {"TopProbabilities", 2}]]
```





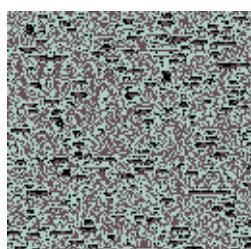
13 655 070

$$\rightarrow \{3 \rightarrow 1.2371 \times 10^{-15}, 4 \rightarrow 1.\},$$



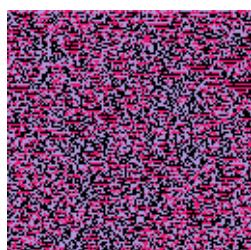
9 614 108

$$\rightarrow \{4 \rightarrow 1.94068 \times 10^{-11}, 3 \rightarrow 1.\},$$



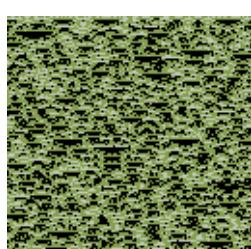
11 960 980

$$\rightarrow \{4 \rightarrow 1.5376 \times 10^{-9}, 3 \rightarrow 1.\},$$



8 698 120

$$\rightarrow \{4 \rightarrow 4.52632 \times 10^{-9}, 3 \rightarrow 1.\},$$

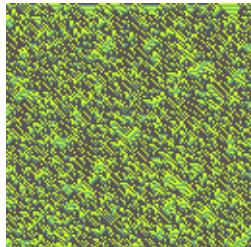


13 126 418

$$\rightarrow \{4 \rightarrow 4.75949 \times 10^{-25}, 3 \rightarrow 1.\}\}$$

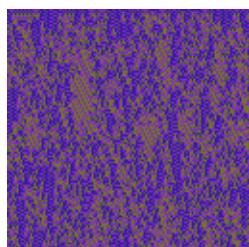
4-colour non-totalistic, range 1

```
In[340]:= test4Data4kr1C18 = datak4r1NT[128, 128, 8];
test4Data4kr1C18labeled = Thread[Labeled[
  Keys@test4Data4kr1C18, Values@test4Data4kr1C18, LabelStyle -> Small]];
Thread[test4Data4kr1C18labeled -> netECA18[Keys@test4Data4kr1C18,
  {"TopProbabilities", 2}]]
```



Out[342]= {
 $\rightarrow \{4 \rightarrow 3.30619 \times 10^{-13}, 3 \rightarrow 1.\},$

47 363 336 282 129 006 026 820 981 542 521 963 471



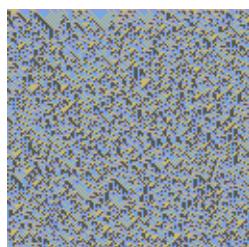
$\rightarrow \{4 \rightarrow 5.80167 \times 10^{-10}, 3 \rightarrow 1.\},$

329 817 774 570 860 109 019 844 624 987 993 225 974



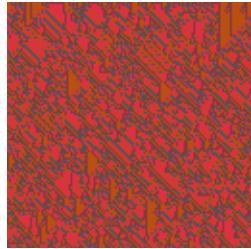
$\rightarrow \{4 \rightarrow 0.00309639, 3 \rightarrow 0.996904\},$

296 989 328 924 775 435 626 986 693 102 679 269 368

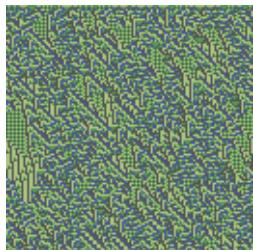


$\rightarrow \{4 \rightarrow 4.8693 \times 10^{-12}, 3 \rightarrow 1.\},$

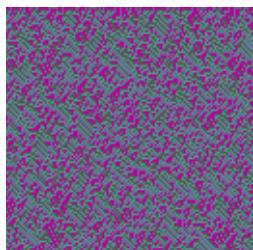
277 043 840 053 627 505 746 917 475 000 616 813 220


 $\rightarrow \{3 \rightarrow 0.000043137, 4 \rightarrow 0.999957\},$

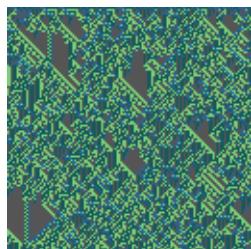
297 372 458 771 516 273 056 931 610 077 577 840 227


 $\rightarrow \{4 \rightarrow 0.0000362744, 3 \rightarrow 0.999964\},$

26 912 895 002 299 472 576 733 451 589 891 132 584

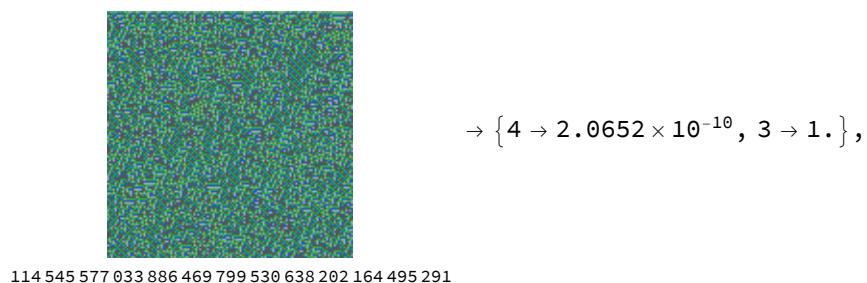
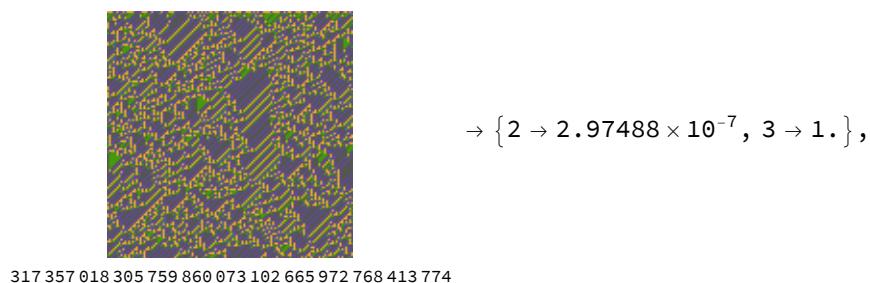
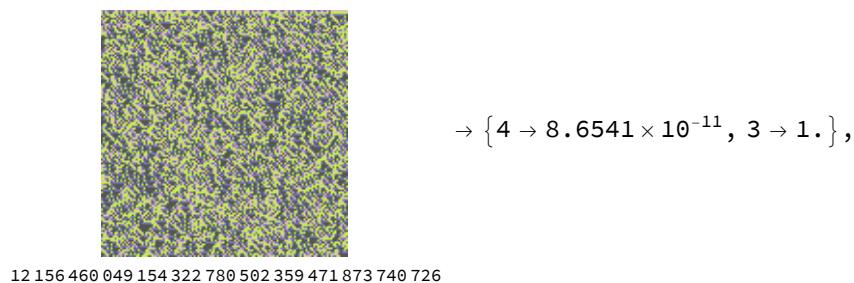
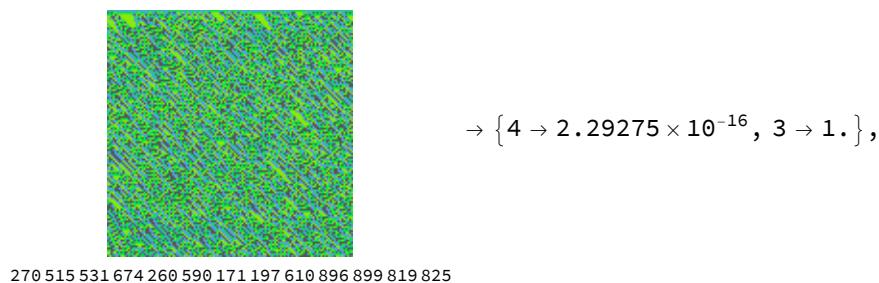
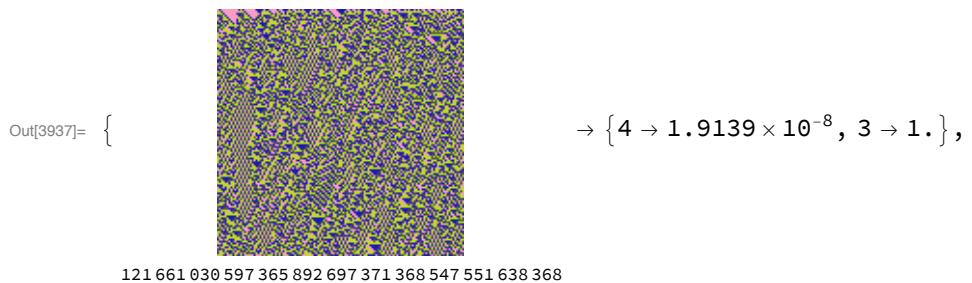

 $\rightarrow \{4 \rightarrow 0.000179133, 3 \rightarrow 0.999821\},$

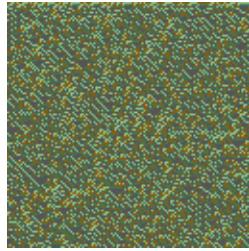
45 190 769 914 069 167 984 586 974 565 370 938 754


 $\rightarrow \{3 \rightarrow 5.37614 \times 10^{-19}, 4 \rightarrow 1.\}\}$

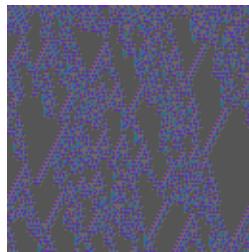
162 808 182 811 890 428 892 567 565 752 290 349 790

```
In[393]:= test4Data4kr1C18 = datak4r1NT[128, 128, 8];
test4Data4kr1C18labeled = Thread[Labeled[
  Keys@test4Data4kr1C18, Values@test4Data4kr1C18, LabelStyle -> Small]];
Thread[test4Data4kr1C18labeled -> netECA18[Keys@test4Data4kr1C18,
 {"TopProbabilities", 2}]]
```

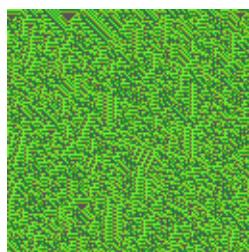



 $\rightarrow \{4 \rightarrow 2.30181 \times 10^{-11}, 3 \rightarrow 1.\},$

220 532 256 712 541 410 926 527 457 151 129 915 755


 $\rightarrow \{3 \rightarrow 2.99322 \times 10^{-11}, 4 \rightarrow 1.\},$

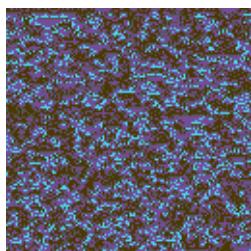
222 068 743 863 034 502 083 690 043 151 842 131 824


 $\rightarrow \{4 \rightarrow 0.0000586015, 3 \rightarrow 0.999941\}\}$

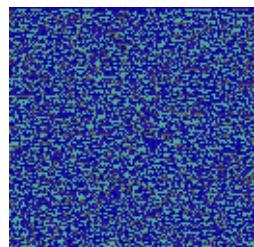
193 363 889 426 070 675 901 637 023 522 685 848 667

4-colour totalistic, range 2

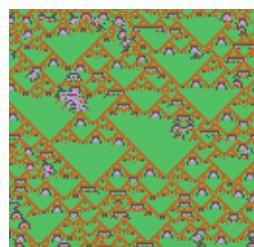
```
In[346]:= test4Data4kr2C18 = datak4r2C[128, 128, 8];
test4Data4kr2C18labeled = Thread[Labeled[
  Keys@test4Data4kr2C18, Values@test4Data4kr2C18, LabelStyle \[Rule] Small]];
Thread[test4Data4kr2C18labeled \[Rule] netECA18[Keys@test4Data4kr2C18,
 {"TopProbabilities", 2}]]
```


 $\rightarrow \{4 \rightarrow 3.19169 \times 10^{-18}, 3 \rightarrow 1.\},$

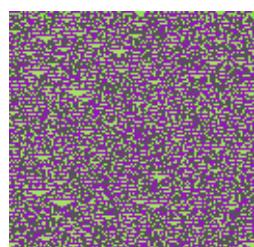
Out[348]= {974 505 478}


$$\rightarrow \{4 \rightarrow 5.4737 \times 10^{-8}, 3 \rightarrow 1.\},$$

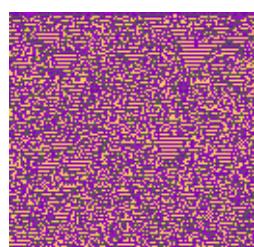
454 439 710


$$\rightarrow \{3 \rightarrow 0.000135287, 4 \rightarrow 0.999865\},$$

3 923 547 398


$$\rightarrow \{4 \rightarrow 4.07997 \times 10^{-7}, 3 \rightarrow 1.\},$$

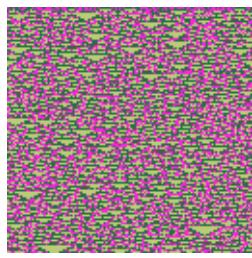
3 585 727 644


$$\rightarrow \{3 \rightarrow 0.363185, 4 \rightarrow 0.636815\},$$

1 717 353 892

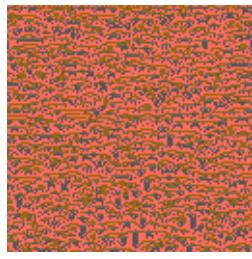

$$\rightarrow \{3 \rightarrow 5.64166 \times 10^{-15}, 4 \rightarrow 1.\},$$

3 421 678 732



$$\rightarrow \{4 \rightarrow 2.15542 \times 10^{-17}, 3 \rightarrow 1.\},$$

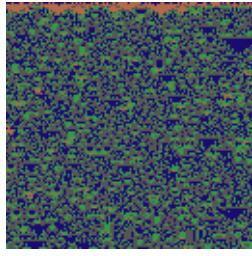
3 575 136 071



$$\rightarrow \{4 \rightarrow 1.07391 \times 10^{-8}, 3 \rightarrow 1.\}\}$$

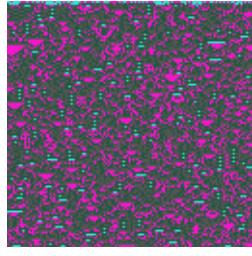
2 794 869 637

```
In[3947]:= test4Data4kr2C18 = data4r2C[128, 128, 8];
test4Data4kr2C18labeled = Thread[Labeled[
  Keys@test4Data4kr2C18, Values@test4Data4kr2C18, LabelStyle -> Small]];
Thread[test4Data4kr2C18labeled -> netECA18[Keys@test4Data4kr2C18,
  {"TopProbabilities", 2}]]
```



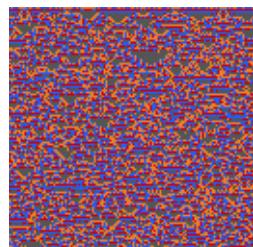
$$\rightarrow \{4 \rightarrow 4.39778 \times 10^{-11}, 3 \rightarrow 1.\},$$

2 392 552 480



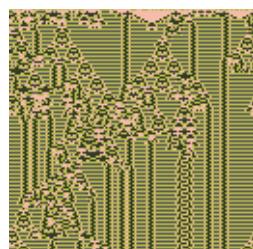
$$\rightarrow \{4 \rightarrow 7.05278 \times 10^{-16}, 3 \rightarrow 1.\},$$

731 879 393



$\rightarrow \{4 \rightarrow 1.15646 \times 10^{-18}, 3 \rightarrow 1.\},$

573 119 742



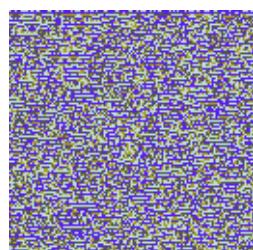
$\rightarrow \{3 \rightarrow 0.349241, 4 \rightarrow 0.650759\},$

4 110 481 242



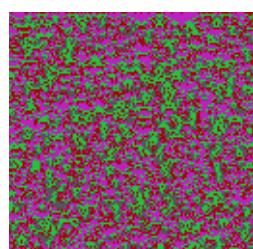
$\rightarrow \{2 \rightarrow 5.41139 \times 10^{-7}, 4 \rightarrow 0.999999\},$

1 392 772 477



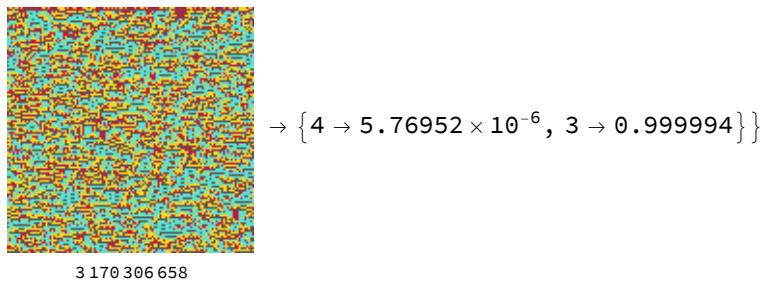
$\rightarrow \{4 \rightarrow 5.8026 \times 10^{-9}, 3 \rightarrow 1.\},$

2 450 567 574



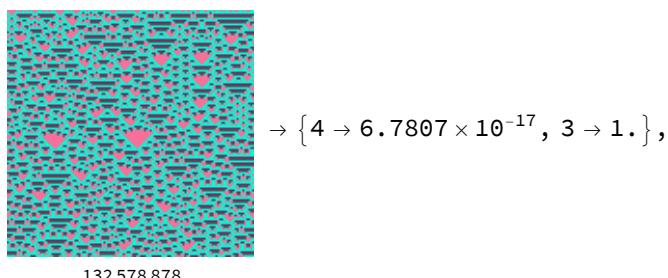
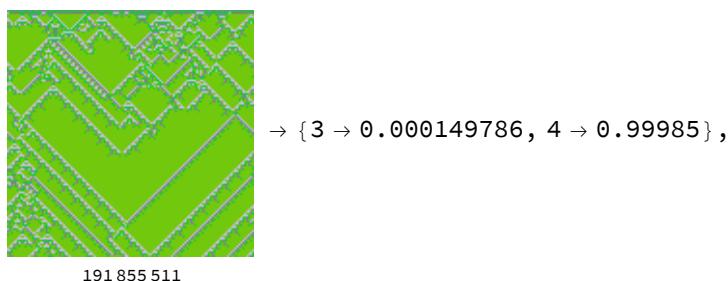
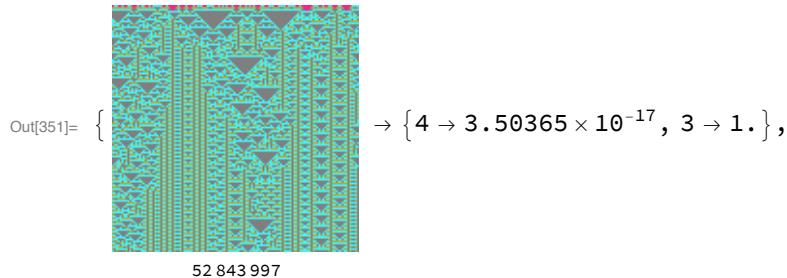
$\rightarrow \{4 \rightarrow 6.7595 \times 10^{-16}, 3 \rightarrow 1.\},$

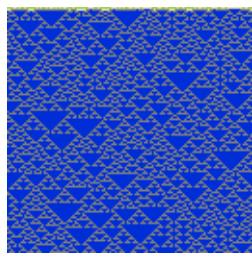
2 011 760 576



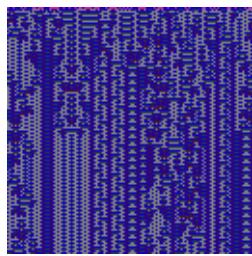
5-colour totalistic, range 1

```
In[349]:= test4Data5kr1C18 = data5T2C[8, 128, 128];
test4Data5kr1C18labeled = Thread[Labeled[
  Keys@test4Data5kr1C18, Values@test4Data5kr1C18, LabelStyle -> Small]];
Thread[test4Data5kr1C18labeled -> netECA18[Keys@test4Data5kr1C18,
 {"TopProbabilities", 2}]]
```

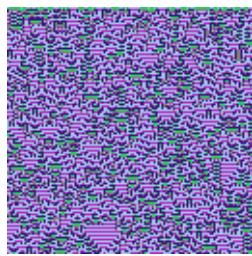


 $\rightarrow \{4 \rightarrow 0.0000493967, 3 \rightarrow 0.999951\},$

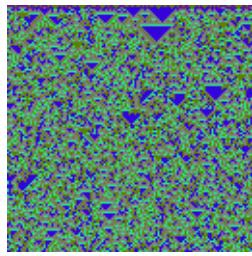
1 050 460 689

 $\rightarrow \{2 \rightarrow 3.37816 \times 10^{-13}, 4 \rightarrow 1.\},$

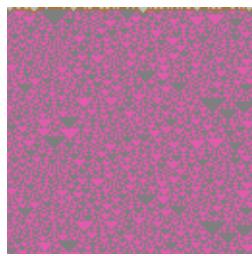
521 486 054

 $\rightarrow \{4 \rightarrow 9.39393 \times 10^{-8}, 3 \rightarrow 1.\},$

208 155 477

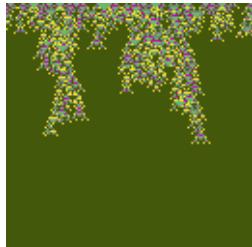
 $\rightarrow \{4 \rightarrow 2.54559 \times 10^{-18}, 3 \rightarrow 1.\},$

1 151 305 852

 $\rightarrow \{4 \rightarrow 1.2891 \times 10^{-27}, 3 \rightarrow 1.\}\}$

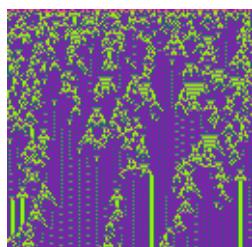
1 054 499 680

```
In[3505]:= test4Data5kr1C18 = data5T2C[8, 128, 128];
test4Data5kr1C18labeled = Thread[Labeled[
  Keys@test4Data5kr1C18, Values@test4Data5kr1C18, LabelStyle -> Small]];
Thread[test4Data5kr1C18labeled -> netECA18[Keys@test4Data5kr1C18,
 {"TopProbabilities", 2}]]
```



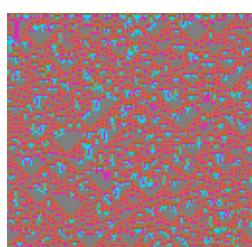
Out[3507]= $\{ \rightarrow \{2 \rightarrow 0.024445, 4 \rightarrow 0.975555\},$

552 070



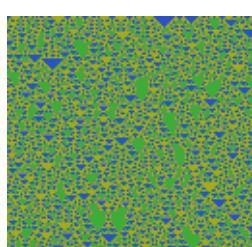
$\rightarrow \{3 \rightarrow 2.64073 \times 10^{-13}, 4 \rightarrow 1.\},$

698 583 519



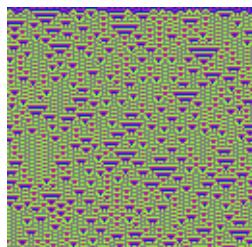
$\rightarrow \{4 \rightarrow 6.19927 \times 10^{-16}, 3 \rightarrow 1.\},$

534 172 366



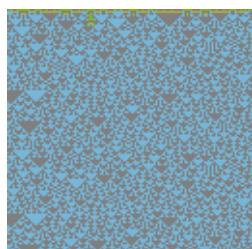
$\rightarrow \{4 \rightarrow 0.00110438, 3 \rightarrow 0.998896\},$

1 117 896 480



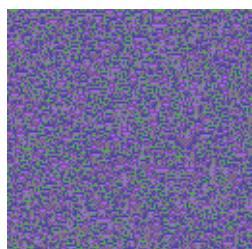
$\rightarrow \{3 \rightarrow 0.17973, 4 \rightarrow 0.82027\},$

77031131



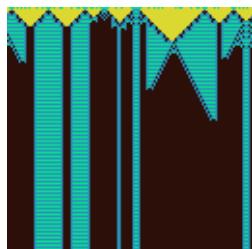
$\rightarrow \{2 \rightarrow 2.60973 \times 10^{-13}, 3 \rightarrow 1.\},$

1196917346



$\rightarrow \{4 \rightarrow 3.63672 \times 10^{-11}, 3 \rightarrow 1.\},$

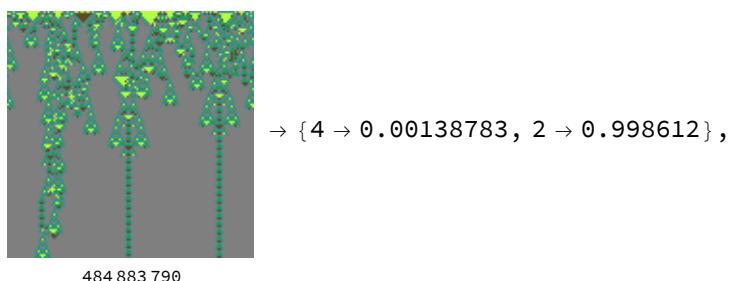
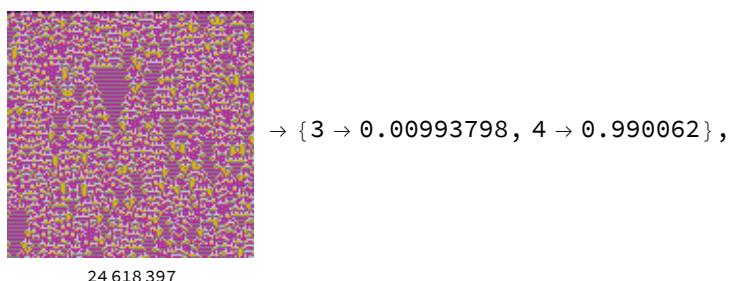
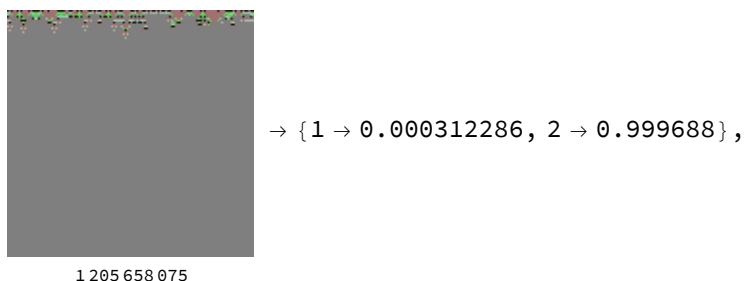
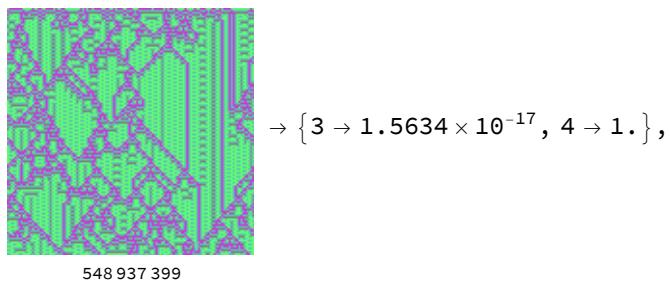
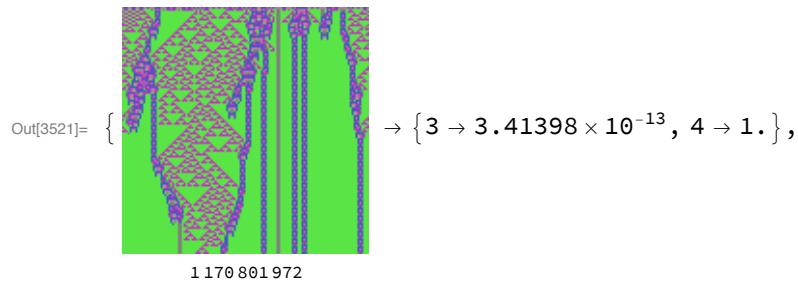
843897982

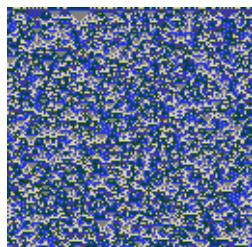


$\rightarrow \{4 \rightarrow 0.280638, 2 \rightarrow 0.719362\}$

476480500

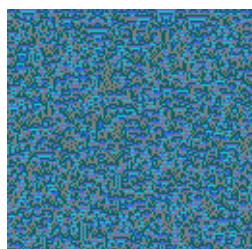
```
In[351]:= test4Data5kr1C18 = data5T2C[8, 128, 128];
test4Data5kr1C18labeled = Thread[Labeled[
  Keys@test4Data5kr1C18, Values@test4Data5kr1C18, LabelStyle -> Small]];
Thread[test4Data5kr1C18labeled -> netECA18[Keys@test4Data5kr1C18,
  {"TopProbabilities", 2}]]
```





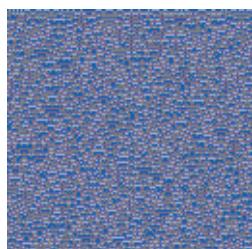
$\rightarrow \{4 \rightarrow 1.13515 \times 10^{-10}, 3 \rightarrow 1.\},$

676 128 741



$\rightarrow \{4 \rightarrow 7.57505 \times 10^{-8}, 3 \rightarrow 1.\},$

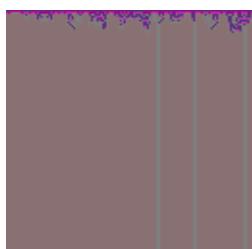
70 861 141



$\rightarrow \{4 \rightarrow 6.93049 \times 10^{-8}, 3 \rightarrow 1.\}\}$

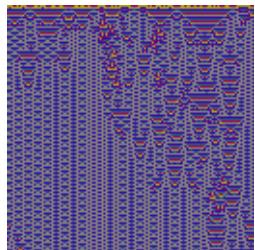
345 919 941

```
In[3543]:= test4Data5kr1C18 = data5T2C[8, 128, 128];
test4Data5kr1C18labeled = Thread[Labeled[
  Keys@test4Data5kr1C18, Values@test4Data5kr1C18, LabelStyle -> Small]];
Thread[test4Data5kr1C18labeled -> netECA18[Keys@test4Data5kr1C18,
  {"TopProbabilities", 2}]]
```



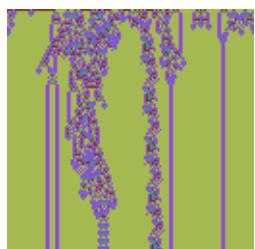
$\rightarrow \{1 \rightarrow 2.41737 \times 10^{-8}, 2 \rightarrow 1.\},$

1 114 437 833



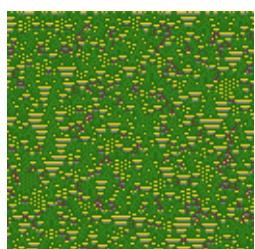
$\rightarrow \{3 \rightarrow 0.0146641, 4 \rightarrow 0.985336\},$

850 778 032



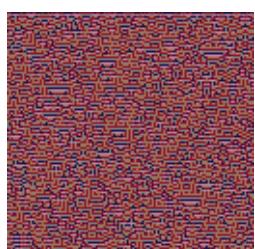
$\rightarrow \{2 \rightarrow 1.56545 \times 10^{-21}, 4 \rightarrow 1.\},$

672 320 710



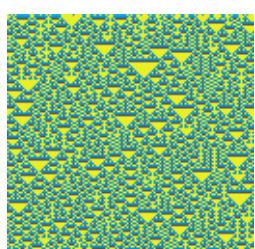
$\rightarrow \{3 \rightarrow 0.000284578, 4 \rightarrow 0.999715\},$

353 410 412



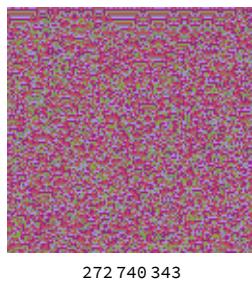
$\rightarrow \{3 \rightarrow 0.00212565, 4 \rightarrow 0.997874\},$

745 400 994

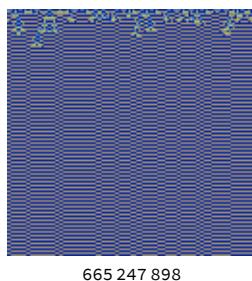


$\rightarrow \{4 \rightarrow 4.85076 \times 10^{-8}, 3 \rightarrow 1.\},$

796 181 700

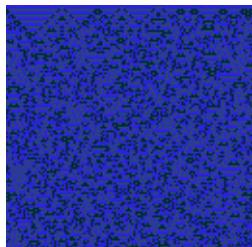


$\rightarrow \{4 \rightarrow 0.0436421, 3 \rightarrow 0.956358\},$

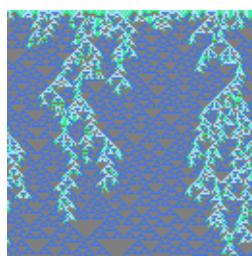


$\rightarrow \{4 \rightarrow 0.000017306, 2 \rightarrow 0.999983\}$

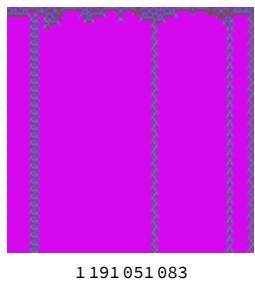
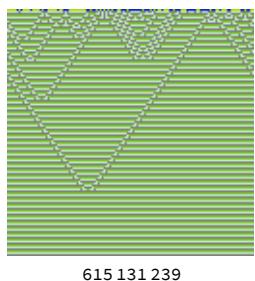
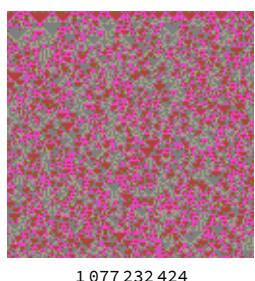
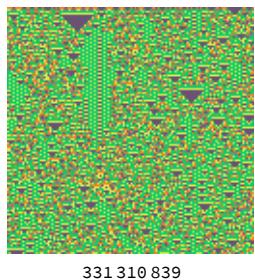
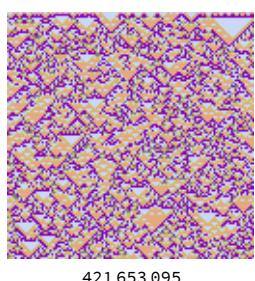
```
In[3551]:= test4Data5kr1C18 = data5T2C[8, 128, 128];
test4Data5kr1C18labeled = Thread[Labeled[
  Keys@test4Data5kr1C18, Values@test4Data5kr1C18, LabelStyle -> Small]];
Thread[test4Data5kr1C18labeled -> netECA18[Keys@test4Data5kr1C18,
 {"TopProbabilities", 2}]]
```

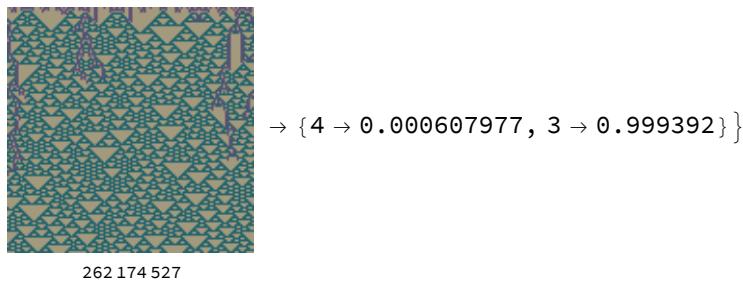


$\rightarrow \{4 \rightarrow 0.0000358762, 3 \rightarrow 0.999964\},$



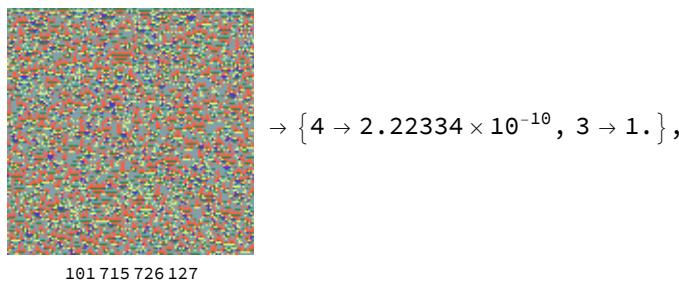
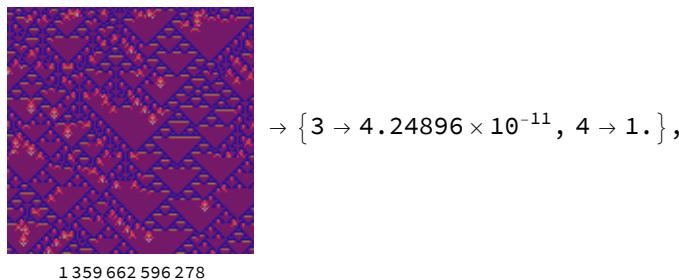
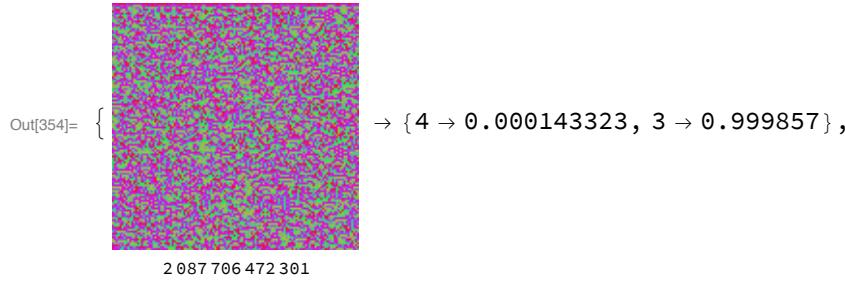
$\rightarrow \{3 \rightarrow 0.000748006, 4 \rightarrow 0.999252\},$

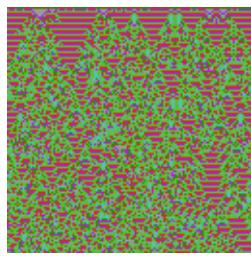

 $\rightarrow \{1 \rightarrow 1.8321 \times 10^{-11}, 2 \rightarrow 1.\},$

 $\rightarrow \{4 \rightarrow 0.0240104, 2 \rightarrow 0.967512\},$

 $\rightarrow \{4 \rightarrow 2.62206 \times 10^{-8}, 3 \rightarrow 1.\},$

 $\rightarrow \{4 \rightarrow 4.08792 \times 10^{-7}, 3 \rightarrow 1.\},$

 $\rightarrow \{4 \rightarrow 3.48109 \times 10^{-16}, 3 \rightarrow 1.\},$



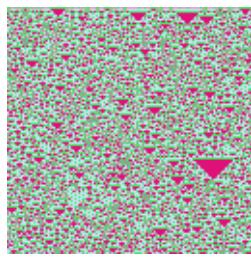
6-colour totalistic, range 1

```
In[352]:= test4Data6kr1C18 = data6TC[8, 128, 128];
test4Data6kr1C18labeled = Thread[Labeled[
  Keys@test4Data6kr1C18, Values@test4Data6kr1C18, LabelStyle -> Small]];
Thread[test4Data6kr1C18labeled -> netECA18[Keys@test4Data6kr1C18,
 {"TopProbabilities", 2}]]
```




$$\rightarrow \{4 \rightarrow 0.00949019, 3 \rightarrow 0.99051\},$$

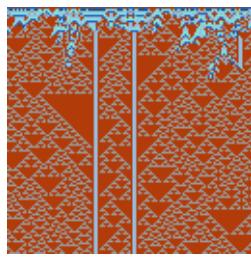
626 135 479 216


$$\rightarrow \{4 \rightarrow 2.7105 \times 10^{-17}, 3 \rightarrow 1.\},$$

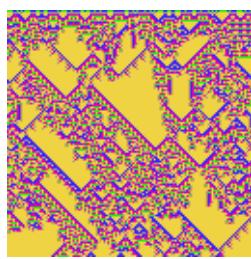
236 160 187 623


$$\rightarrow \{2 \rightarrow 0.000408826, 1 \rightarrow 0.999591\},$$

2 194 216 283 700

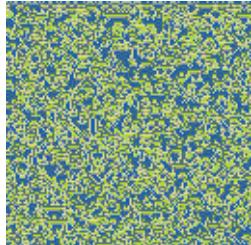

$$\rightarrow \{3 \rightarrow 1.58059 \times 10^{-15}, 4 \rightarrow 1.\},$$

282 791 124 711


$$\rightarrow \{3 \rightarrow 2.46304 \times 10^{-19}, 4 \rightarrow 1.\}\}$$

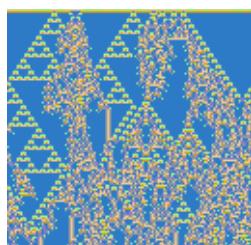
585 122 220 446

```
In[3442]:= test4Data6kr1C18 = data6TC[8, 128, 128];
test4Data6kr1C18labeled = Thread[Labeled[
  Keys@test4Data6kr1C18, Values@test4Data6kr1C18, LabelStyle -> Small]];
Thread[test4Data6kr1C18labeled -> netECA18[Keys@test4Data6kr1C18,
 {"TopProbabilities", 2}]]
```



```
Out[3444]= {4 -> 1.12283 × 10-8, 3 -> 1.},
```

2 082 202 326 453



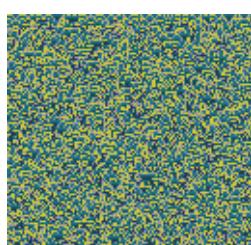
```
→ {3 -> 1.68035 × 10-16, 4 -> 1.},
```

2 441 577 964 996



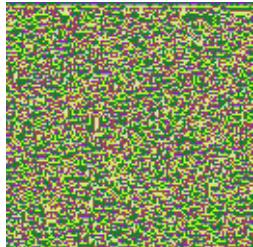
```
→ {4 -> 0.0042745, 3 -> 0.995726},
```

2 228 562 968 395



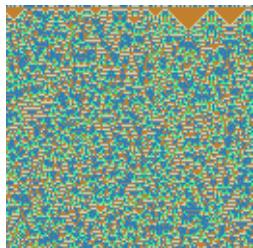
```
→ {4 -> 3.8978 × 10-6, 3 -> 0.999996},
```

577 808 139 177



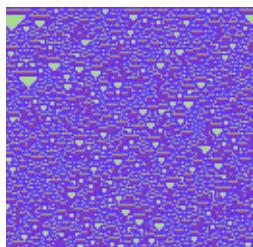
$$\rightarrow \{4 \rightarrow 1.45188 \times 10^{-8}, 3 \rightarrow 1.\},$$

1 939 834 362 968



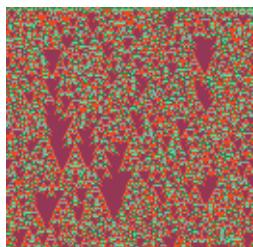
$$\rightarrow \{4 \rightarrow 2.51092 \times 10^{-8}, 3 \rightarrow 1.\},$$

480 001 852 106



$$\rightarrow \{4 \rightarrow 6.4349 \times 10^{-12}, 3 \rightarrow 1.\},$$

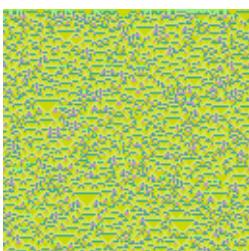
2 704 714 386 707

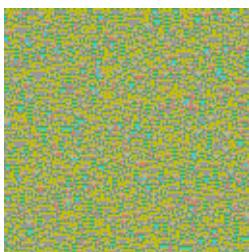


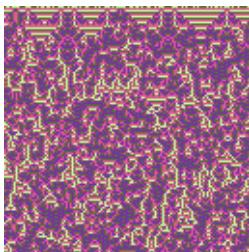
$$\rightarrow \{3 \rightarrow 0.000014885, 4 \rightarrow 0.999985\}$$

2 658 677 296 974

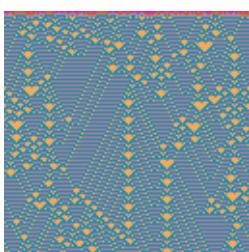
```
In[3483]:= test4Data6kr1C18 = data6TC[8, 128, 128];
test4Data6kr1C18labeled = Thread[Labeled[
  Keys@test4Data6kr1C18, Values@test4Data6kr1C18, LabelStyle -> Small]];
Thread[test4Data6kr1C18labeled -> netECA18[Keys@test4Data6kr1C18,
 {"TopProbabilities", 2}]]
```

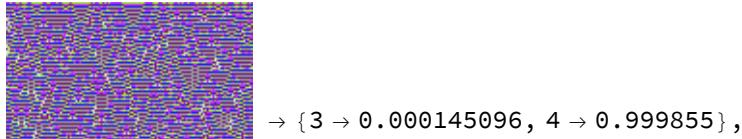
Out[3485]= 
 $\rightarrow \{4 \rightarrow 1.65647 \times 10^{-9}, 3 \rightarrow 1.\},$
1 471 445 509 302


 $\rightarrow \{4 \rightarrow 2.12032 \times 10^{-17}, 3 \rightarrow 1.\},$
663 707 107 061

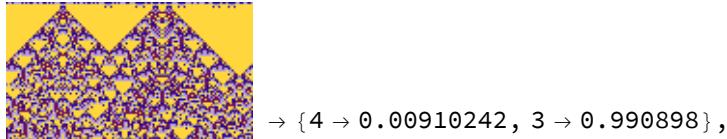

 $\rightarrow \{4 \rightarrow 0.0182532, 3 \rightarrow 0.981747\},$
435 066 764 539


 $\rightarrow \{2 \rightarrow 1.58065 \times 10^{-10}, 1 \rightarrow 1.\},$
983 936 355 264

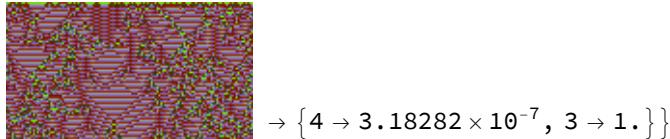

 $\rightarrow \{4 \rightarrow 0.143164, 3 \rightarrow 0.856836\},$
2 194 054 910 860



1 049 235 927 151



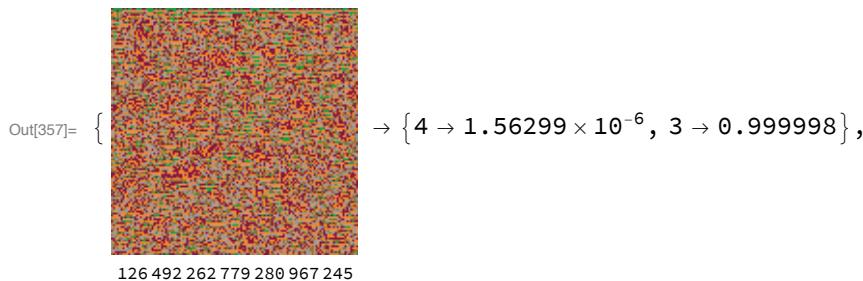
2 295 277 733 836

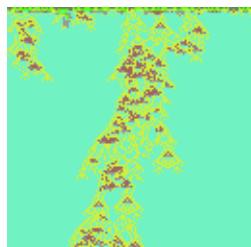


328 582 694 180

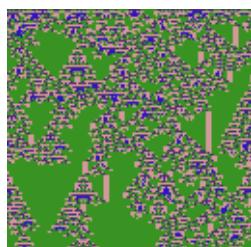
6-colour totalistic, range 2

```
In[355]:= test4Data6kr2C18 = data6T2C[8, 128, 128];
test4Data6kr2C18labeled = Thread[Labeled[
  Keys@test4Data6kr2C18, Values@test4Data6kr2C18, LabelStyle -> Small]];
Thread[test4Data6kr2C18labeled -> netECA18[Keys@test4Data6kr2C18,
  {"TopProbabilities", 2}]]
```

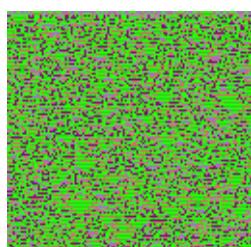



$$\rightarrow \{3 \rightarrow 1.71257 \times 10^{-19}, 4 \rightarrow 1.\},$$

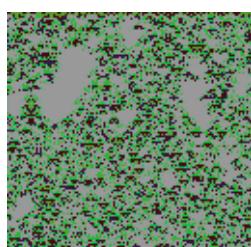
170 164 089 950 923 780 299


$$\rightarrow \{3 \rightarrow 8.95514 \times 10^{-13}, 4 \rightarrow 1.\},$$

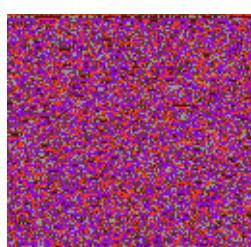
155 892 327 712 219 067 638


$$\rightarrow \{4 \rightarrow 1.25818 \times 10^{-8}, 3 \rightarrow 1.\},$$

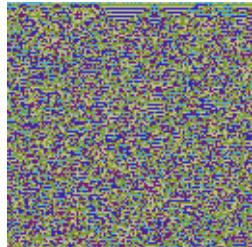
93 368 100 412 663 805 755


$$\rightarrow \{4 \rightarrow 4.75288 \times 10^{-6}, 3 \rightarrow 0.999995\},$$

135 899 886 200 004 305 929

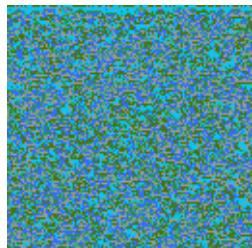

$$\rightarrow \{4 \rightarrow 3.28831 \times 10^{-13}, 3 \rightarrow 1.\},$$

40 491 495 414 090 990 843



$\rightarrow \{4 \rightarrow 0.00354854, 3 \rightarrow 0.996451\},$

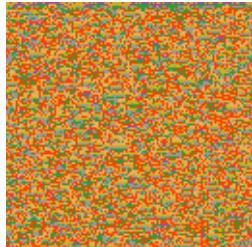
52 482 358 297 896 098 096



$\rightarrow \{4 \rightarrow 9.04766 \times 10^{-8}, 3 \rightarrow 1.\}\}$

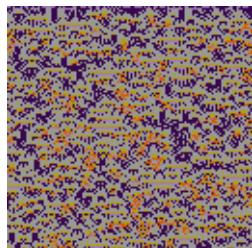
126 066 113 157 629 415 623

```
In[3415]:= test4Data6kr2C18 = data6T2C[8, 128, 128];
test4Data6kr2C18labeled = Thread[Labeled[
  Keys@test4Data6kr2C18, Values@test4Data6kr2C18, LabelStyle -> Small]];
Thread[test4Data6kr2C18labeled -> netECA18[Keys@test4Data6kr2C18,
 {"TopProbabilities", 2}]]
```



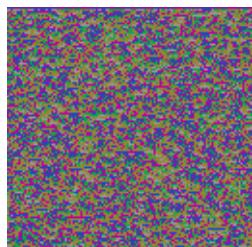
$\rightarrow \{4 \rightarrow 1.32215 \times 10^{-13}, 3 \rightarrow 1.\},$

116 251 108 197 027 233 170

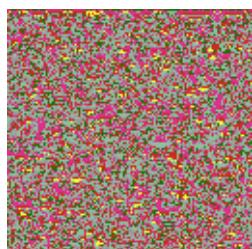


$\rightarrow \{4 \rightarrow 1.89168 \times 10^{-12}, 3 \rightarrow 1.\},$

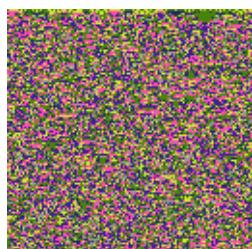
51 426 966 698 055 146 382


$$\rightarrow \{4 \rightarrow 2.82414 \times 10^{-9}, 3 \rightarrow 1.\},$$

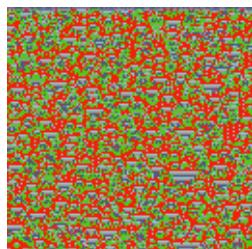
110 148 932 517 907 174 739


$$\rightarrow \{4 \rightarrow 0.000116244, 3 \rightarrow 0.999884\},$$

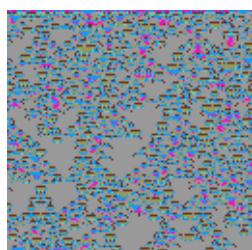
66 200 260 018 158 479 699


$$\rightarrow \{4 \rightarrow 3.77945 \times 10^{-11}, 3 \rightarrow 1.\},$$

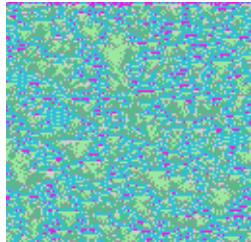
167 615 171 111 996 910 244


$$\rightarrow \{4 \rightarrow 2.94699 \times 10^{-9}, 3 \rightarrow 1.\},$$

68 475 339 347 989 125 695


$$\rightarrow \{3 \rightarrow 5.29148 \times 10^{-7}, 4 \rightarrow 0.999999\},$$

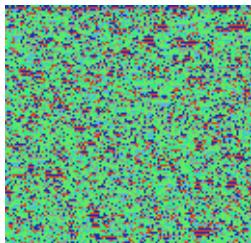
130 871 229 950 004 203 204



$$\rightarrow \{4 \rightarrow 5.50694 \times 10^{-7}, 3 \rightarrow 0.999999\}\}$$

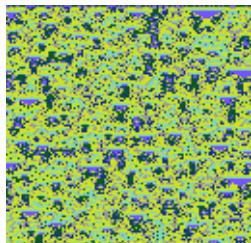
84 956 199 859 036 906 408

```
In[3430]:= test4Data6kr2C18 = data6T2C[8, 128, 128];
test4Data6kr2C18labeled = Thread[Labeled[
  Keys@test4Data6kr2C18, Values@test4Data6kr2C18, LabelStyle -> Small]];
Thread[test4Data6kr2C18labeled -> netECA18[Keys@test4Data6kr2C18,
  {"TopProbabilities", 2}]]
```



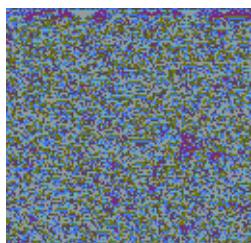
$$\rightarrow \{4 \rightarrow 6.674 \times 10^{-8}, 3 \rightarrow 1.\},$$

409 883 879 143 537 667



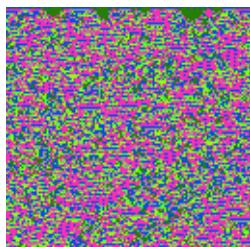
$$\rightarrow \{4 \rightarrow 4.86254 \times 10^{-16}, 3 \rightarrow 1.\},$$

22 373 739 204 525 571 194

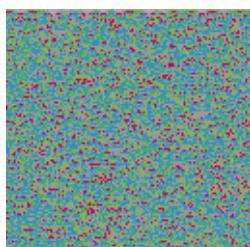


$$\rightarrow \{4 \rightarrow 2.43792 \times 10^{-7}, 3 \rightarrow 1.\},$$

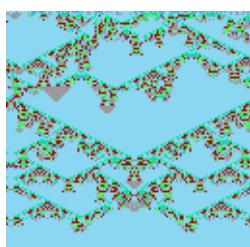
125 552 061 450 101 947 158


 $\rightarrow \{4 \rightarrow 0.007696, 3 \rightarrow 0.992304\},$

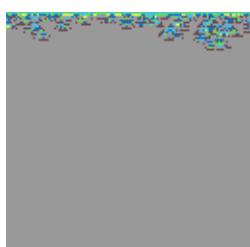
169 226 385 023 170 845 504


 $\rightarrow \{4 \rightarrow 1.70408 \times 10^{-17}, 3 \rightarrow 1.\},$

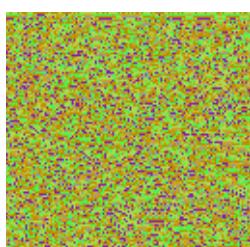
70 866 299 155 337 117 496


 $\rightarrow \{3 \rightarrow 2.76215 \times 10^{-7}, 4 \rightarrow 1.\},$

10 717 385 736 670 401 684


 $\rightarrow \{4 \rightarrow 0.362329, 2 \rightarrow 0.637671\},$

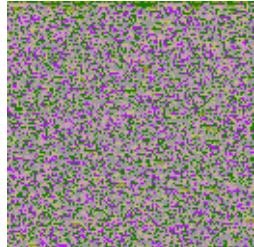
78 513 876 277 937 070 738


 $\rightarrow \{4 \rightarrow 0.0998584, 3 \rightarrow 0.900142\}$

82 676 937 375 933 533 051

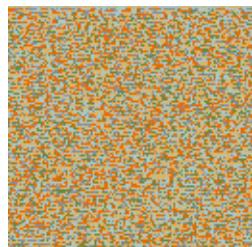
6 colour totalistic, range 3

```
In[4085]:= test4Data6kr3C18 = data6T3C[8, 128, 128];
test4Data6kr3C18labeled = Thread[Labeled[
  Keys@test4Data6kr3C18, Values@test4Data6kr3C18, LabelStyle -> Small]];
Thread[test4Data6kr3C18labeled -> netECA18[Keys@test4Data6kr3C18,
 {"TopProbabilities", 2}]]
```



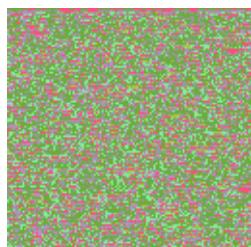
Out[4087]= $\{ \rightarrow \{4 \rightarrow 6.5026 \times 10^{-8}, 3 \rightarrow 1.\},$

430 465 428 382 441 528 803 646 931



$\rightarrow \{4 \rightarrow 2.81827 \times 10^{-10}, 3 \rightarrow 1.\},$

10 033 852 952 847 774 114 304 998 229



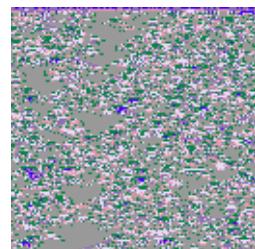
$\rightarrow \{4 \rightarrow 1.78359 \times 10^{-8}, 3 \rightarrow 1.\},$

5 571 170 684 698 482 074 189 657 521



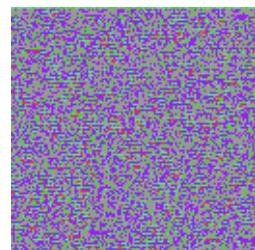
$\rightarrow \{4 \rightarrow 7.90051 \times 10^{-6}, 3 \rightarrow 0.999992\},$

1 960 073 338 185 569 956 999 257 251



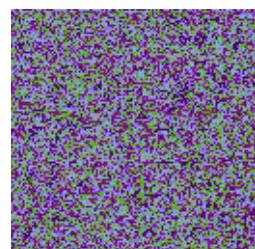
$\rightarrow \{4 \rightarrow 0.0000108734, 3 \rightarrow 0.999989\},$

2 580 373 036 647 671 990 459 567 103



$\rightarrow \{4 \rightarrow 1.60516 \times 10^{-10}, 3 \rightarrow 1.\},$

3 035 176 094 273 459 693 252 275 995



$\rightarrow \{4 \rightarrow 0.128035, 3 \rightarrow 0.871965\},$

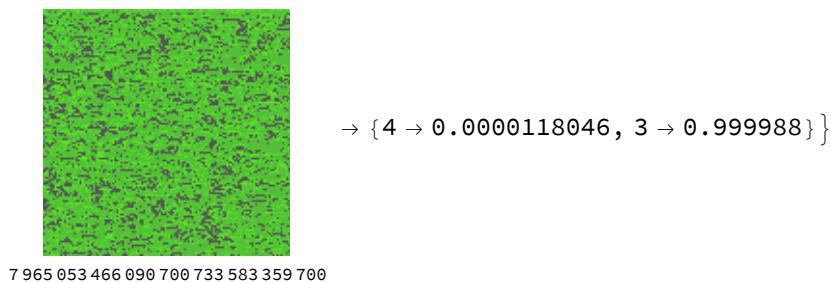
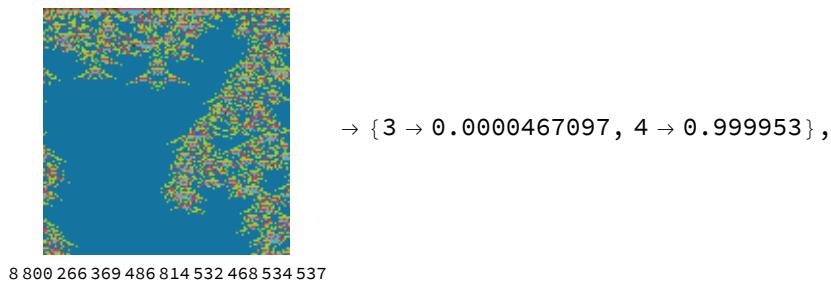
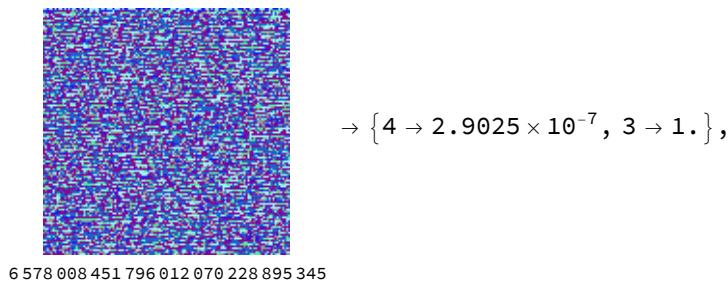
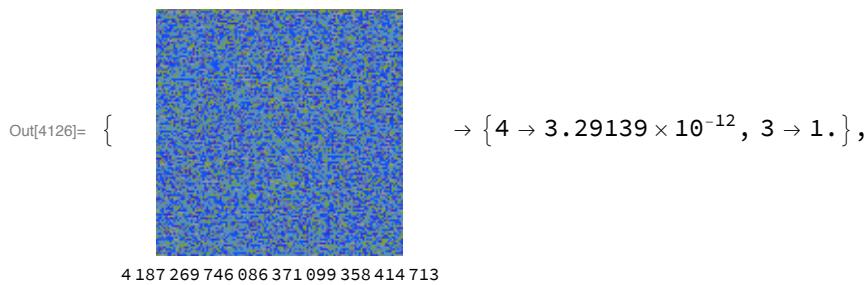
2 802 947 023 878 010 353 769 017 664



$\rightarrow \{4 \rightarrow 4.41178 \times 10^{-8}, 3 \rightarrow 1.\}\}$

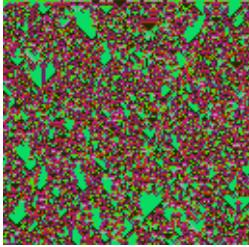
602 655 983 015 559 295 059 479 411

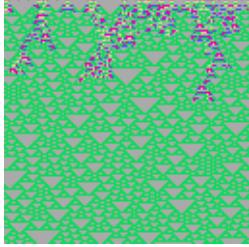
```
In[4124]:= test4Data6kr3C18 = data6T3C[4, 128, 128];
test4Data6kr3C18labeled = Thread[Labeled[
  Keys@test4Data6kr3C18, Values@test4Data6kr3C18, LabelStyle -> Small]];
Thread[test4Data6kr3C18labeled -> netECA18[Keys@test4Data6kr3C18,
 {"TopProbabilities", 2}]]
```

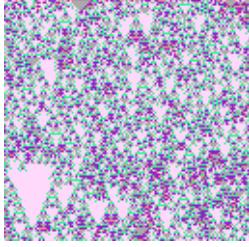


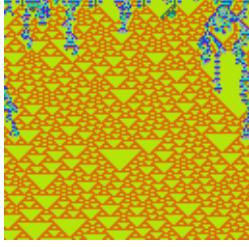
7-colour totalistic, range 1

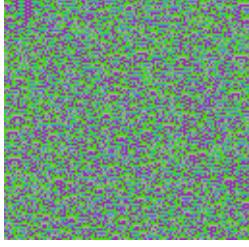
```
In[373]:= test4Data7kr1C18 = data7TC[8, 128, 128];  
test4Data7kr1C18labeled = Thread[Labeled[  
    Keys@test4Data7kr1C18, Values@test4Data7kr1C18, LabelStyle → Small]];  
Thread[test4Data7kr1C18labeled → netECA18[Keys@test4Data7kr1C18,  
    {"TopProbabilities", 2}]]
```

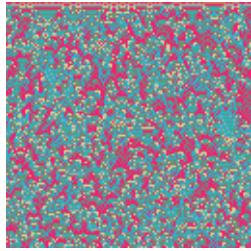
Out[375]= 
 $\rightarrow \{4 \rightarrow 0.000603501, 3 \rightarrow 0.999397\},$
5 419 415 476 292 874


 $\rightarrow \{4 \rightarrow 1.58323 \times 10^{-9}, 3 \rightarrow 1.\},$
5 263 032 896 718 823


 $\rightarrow \{2 \rightarrow 4.05481 \times 10^{-11}, 4 \rightarrow 1.\},$
7 020 291 676 264 106

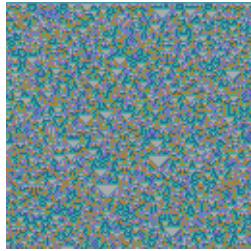

 $\rightarrow \{2 \rightarrow 7.7001 \times 10^{-21}, 4 \rightarrow 1.\},$
1 156 837 474 592 456


 $\rightarrow \{4 \rightarrow 0.00665255, 3 \rightarrow 0.993347\},$
975 822 040 535 045



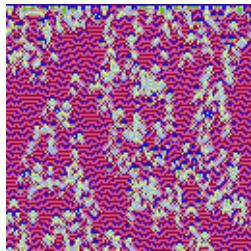
$$\rightarrow \{4 \rightarrow 2.9215 \times 10^{-8}, 3 \rightarrow 1.\},$$

6 831 445 863 597 275



$$\rightarrow \{4 \rightarrow 4.22974 \times 10^{-19}, 3 \rightarrow 1.\},$$

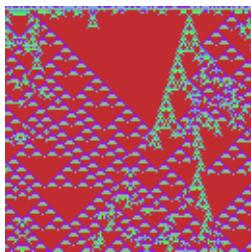
2 999 900 742 201 901



$$\rightarrow \{4 \rightarrow 1.14567 \times 10^{-16}, 3 \rightarrow 1.\}\}$$

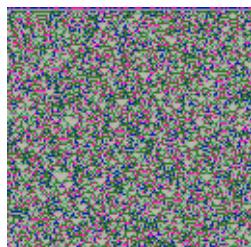
4 165 489 127 562 489

```
In[3343]:= test4Data7kr1C18 = data7TC[8, 128, 128];
test4Data7kr1C18labeled = Thread[Labeled[
  Keys@test4Data7kr1C18, Values@test4Data7kr1C18, LabelStyle -> Small]];
Thread[test4Data7kr1C18labeled -> netECA18[Keys@test4Data7kr1C18,
 {"TopProbabilities", 2}]]
```

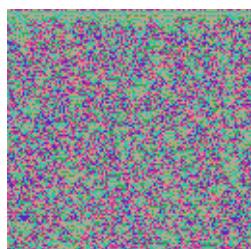


$$\rightarrow \{4 \rightarrow 0.0370363, 3 \rightarrow 0.962964\},$$

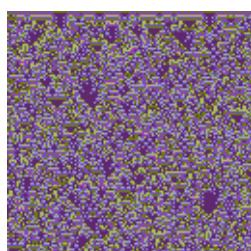
9 391 791 736 290 991


$$\rightarrow \{4 \rightarrow 8.94328 \times 10^{-16}, 3 \rightarrow 1.\},$$

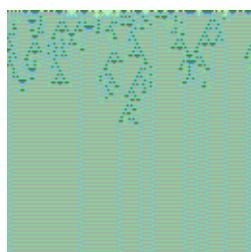
10 824 074 240 813 108


$$\rightarrow \{4 \rightarrow 4.80133 \times 10^{-9}, 3 \rightarrow 1.\},$$

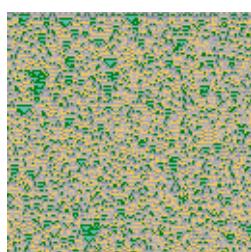
4 397 310 427 869 391


$$\rightarrow \{4 \rightarrow 0.0218051, 3 \rightarrow 0.978195\},$$

1 357 817 407 057 042


$$\rightarrow \{3 \rightarrow 1.55854 \times 10^{-11}, 4 \rightarrow 1.\},$$

3 268 293 146 684 716

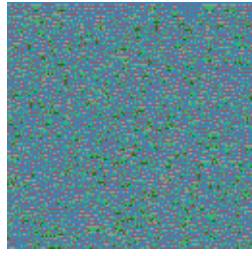

$$\rightarrow \{4 \rightarrow 6.84897 \times 10^{-15}, 3 \rightarrow 1.\},$$

11 131 902 177 548 346



$$\rightarrow \{2 \rightarrow 1.34407 \times 10^{-7}, 1 \rightarrow 1.\},$$

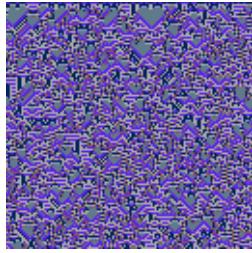
5 574 110 686 773 391



$$\rightarrow \{4 \rightarrow 3.09918 \times 10^{-9}, 3 \rightarrow 1.\}\}$$

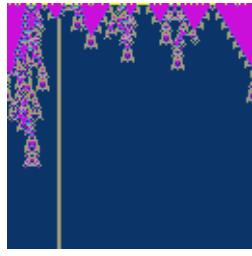
8 843 022 895 383 248

```
In[3361]:= test4Data7kr1C18 = data7TC[8, 128, 128];
test4Data7kr1C18labeled = Thread[Labeled[
  Keys@test4Data7kr1C18, Values@test4Data7kr1C18, LabelStyle -> Small]];
Thread[test4Data7kr1C18labeled -> netECA18[Keys@test4Data7kr1C18,
 {"TopProbabilities", 2}]]
```



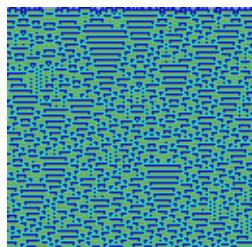
$$\rightarrow \{4 \rightarrow 1.38725 \times 10^{-19}, 3 \rightarrow 1.\},$$

7 512 741 445 891 534

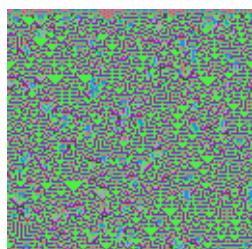


$$\rightarrow \{2 \rightarrow 1.93004 \times 10^{-8}, 4 \rightarrow 1.\},$$

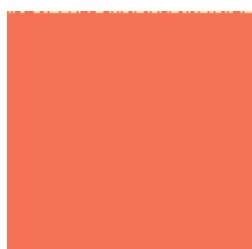
4 656 445 834 171 866


$$\rightarrow \{3 \rightarrow 1.81968 \times 10^{-10}, 4 \rightarrow 1.\},$$

3 661 418 684 664 681


$$\rightarrow \{4 \rightarrow 0.000673255, 3 \rightarrow 0.999327\},$$

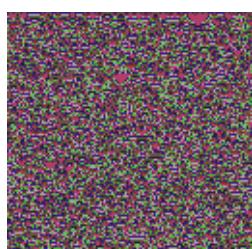
8 977 606 989 334 362


$$\rightarrow \{2 \rightarrow 0.000013577, 1 \rightarrow 0.999986\},$$

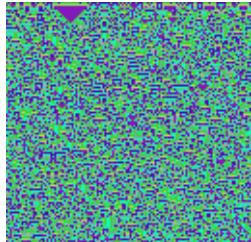
7 746 139 156 570 585


$$\rightarrow \{3 \rightarrow 0.00128793, 4 \rightarrow 0.998712\},$$

29 363 162 783 321


$$\rightarrow \{4 \rightarrow 4.46761 \times 10^{-14}, 3 \rightarrow 1.\},$$

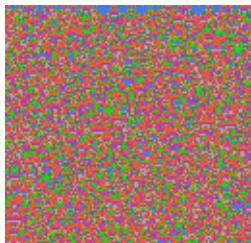
10 963 215 518 926 997



$\rightarrow \{4 \rightarrow 6.15047 \times 10^{-16}, 3 \rightarrow 1.\}\}$

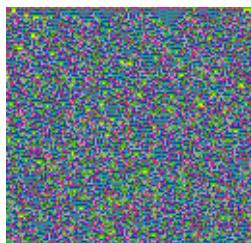
7 259 976 727 752 201

```
In[3606]:= test4Data7kr1C18 = data7TC[8, 128, 128];
test4Data7kr1C18labeled = Thread[Labeled[
  Keys@test4Data7kr1C18, Values@test4Data7kr1C18, LabelStyle -> Small]];
Thread[test4Data7kr1C18labeled -> netECA18[Keys@test4Data7kr1C18,
 {"TopProbabilities", 2}]]
```



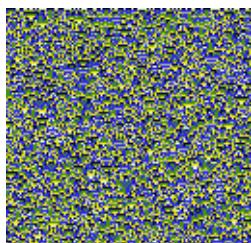
$\rightarrow \{4 \rightarrow 6.08898 \times 10^{-16}, 3 \rightarrow 1.\},$

4 577 225 035 048 435



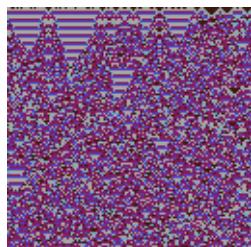
$\rightarrow \{4 \rightarrow 1.67555 \times 10^{-10}, 3 \rightarrow 1.\},$

7 658 792 313 876 570

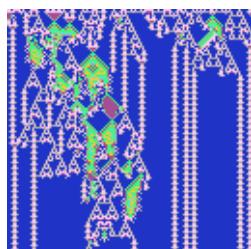


$\rightarrow \{4 \rightarrow 2.3118 \times 10^{-6}, 3 \rightarrow 0.999998\},$

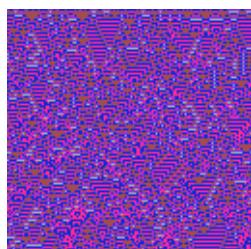
2 559 553 690 479 558


$$\rightarrow \{4 \rightarrow 2.17667 \times 10^{-7}, 3 \rightarrow 1.\},$$

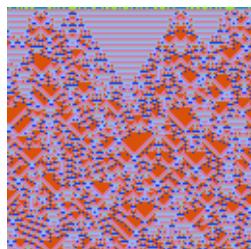
4 304 886 999 310 639


$$\rightarrow \{3 \rightarrow 1.49351 \times 10^{-13}, 4 \rightarrow 1.\},$$

4 584 669 469 683 292


$$\rightarrow \{4 \rightarrow 9.24085 \times 10^{-8}, 3 \rightarrow 1.\},$$

10 401 927 119 101 408

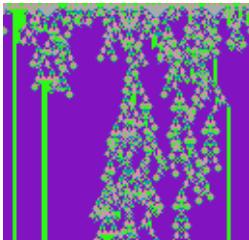

$$\rightarrow \{4 \rightarrow 0.27836, 3 \rightarrow 0.72164\},$$

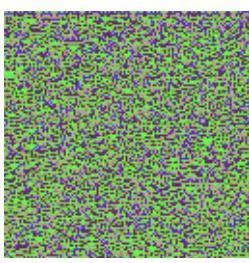
9 285 396 877 131 377

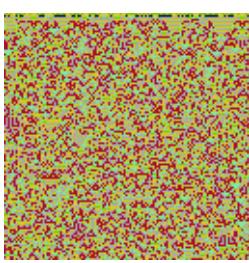

$$\rightarrow \{2 \rightarrow 9.06222 \times 10^{-8}, 4 \rightarrow 1.\}\}$$

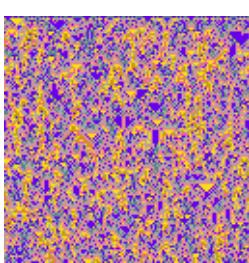
11 015 263 135 036 963

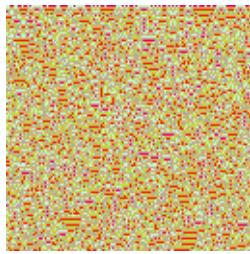
```
In[3634]:= test4Data7kr1C18 = data7TC[8, 128, 128];
test4Data7kr1C18labeled = Thread[Labeled[
  Keys@test4Data7kr1C18, Values@test4Data7kr1C18, LabelStyle -> Small]];
Thread[test4Data7kr1C18labeled -> netECA18[Keys@test4Data7kr1C18,
  {"TopProbabilities", 2}]]
```

Out[3636]= { → {3 → 7.25859 × 10⁻²³, 4 → 1.},
10 193 067 898 860 176}

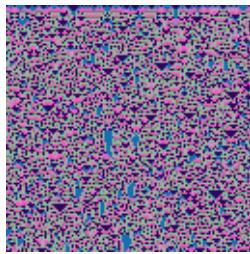
 → {4 → 1.15175 × 10⁻⁹, 3 → 1.},
4 439 619 465 099 332

 → {4 → 6.95165 × 10⁻⁶, 3 → 0.999993},
3 348 425 903 198 195

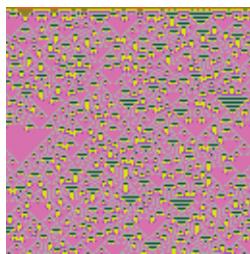
 → {4 → 1.52245 × 10⁻⁷, 3 → 1.},
602 231 180 686 667


 $\rightarrow \{4 \rightarrow 1.36997 \times 10^{-12}, 3 \rightarrow 1.\},$

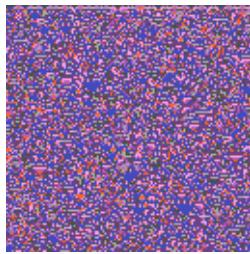
520 630 642 839 836


 $\rightarrow \{4 \rightarrow 0.195729, 3 \rightarrow 0.804271\},$

4 835 221 296 961 468


 $\rightarrow \{4 \rightarrow 0.330814, 3 \rightarrow 0.669186\},$

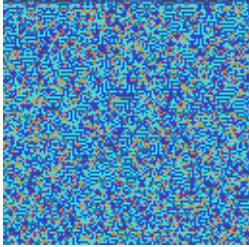
3 673 610 778 480 762

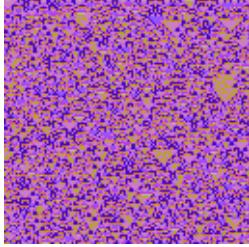

 $\rightarrow \{4 \rightarrow 3.07015 \times 10^{-17}, 3 \rightarrow 1.\}\}$

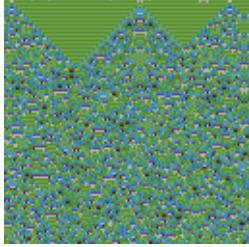
9 864 034 046 017 416

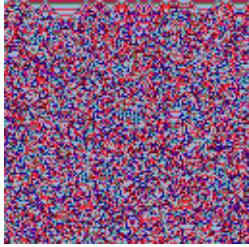
8-colour totalistic, range 1

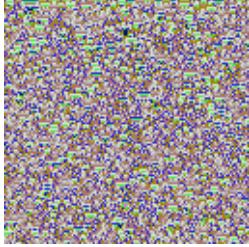
```
In[3329]:= test4Data8kr1C18 = data8TC[8, 128, 128];
test4Data8kr1C18labeled = Thread[Labeled[
  Keys@test4Data8kr1C18, Values@test4Data8kr1C18, LabelStyle -> Small]];
Thread[test4Data8kr1C18labeled -> netECA18[Keys@test4Data8kr1C18,
 {"TopProbabilities", 2}]]
```

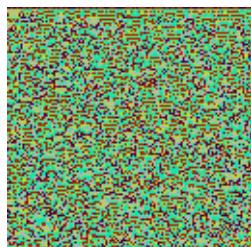
Out[3331]=  $\rightarrow \{4 \rightarrow 0.0000843203, 3 \rightarrow 0.999916\},$
 34 793 729 905 269 548 653

 $\rightarrow \{4 \rightarrow 6.88964 \times 10^{-15}, 3 \rightarrow 1.\},$
 63 374 858 180 573 796 594

 $\rightarrow \{4 \rightarrow 1.32724 \times 10^{-13}, 3 \rightarrow 1.\},$
 19 616 575 778 924 418 778

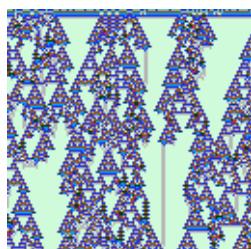
 $\rightarrow \{4 \rightarrow 0.0000425419, 3 \rightarrow 0.999957\},$
 7 713 400 236 056 986 842

 $\rightarrow \{4 \rightarrow 1.75281 \times 10^{-8}, 3 \rightarrow 1.\},$
 13 216 035 164 976 881 943



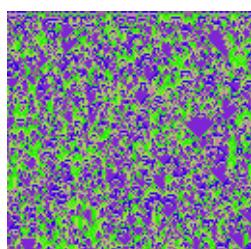
$$\rightarrow \{4 \rightarrow 1.90301 \times 10^{-6}, 3 \rightarrow 0.999998\},$$

55 788 358 267 537 493 758



$$\rightarrow \{2 \rightarrow 1.61208 \times 10^{-19}, 4 \rightarrow 1.\},$$

37 807 578 142 261 186 506



$$\rightarrow \{4 \rightarrow 0.00018774, 3 \rightarrow 0.999812\}$$

28 281 723 580 115 711 352

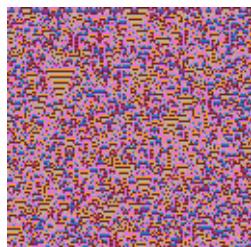
```
In[379]:= test4Data8kr1C18 = data8TC[8, 128, 128];
test4Data8kr1C18labeled = Thread[Labeled[
  Keys@test4Data8kr1C18, Values@test4Data8kr1C18, LabelStyle -> Small]];
Thread[test4Data8kr1C18labeled -> netECA18[Keys@test4Data8kr1C18,
 {"TopProbabilities", 2}]]
```



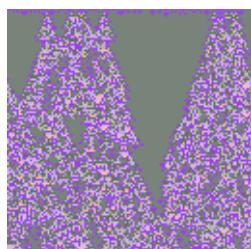
$$\rightarrow \{4 \rightarrow 1.25442 \times 10^{-20}, 3 \rightarrow 1.\},$$

Out[381]= {

50 929 070 805 542 865 748


 $\rightarrow \{4 \rightarrow 0.137072, 3 \rightarrow 0.862928\},$

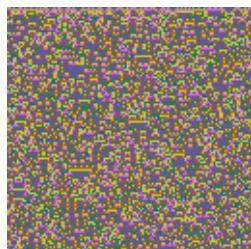
27 586 839 754 323 551 733


 $\rightarrow \{3 \rightarrow 2.12525 \times 10^{-8}, 4 \rightarrow 1.\},$

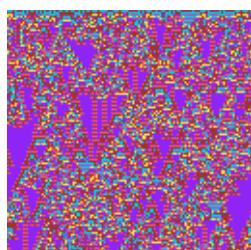
44 346 528 569 663 390 240


 $\rightarrow \{4 \rightarrow 0.000612088, 3 \rightarrow 0.999388\},$

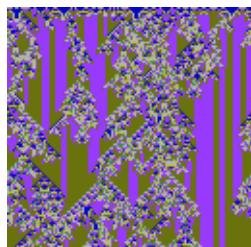
41 611 153 852 033 383 161


 $\rightarrow \{4 \rightarrow 5.68443 \times 10^{-18}, 3 \rightarrow 1.\},$

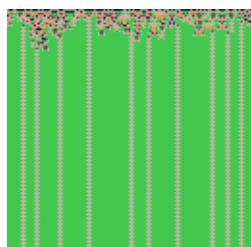
52 397 043 003 283 631 304


 $\rightarrow \{3 \rightarrow 3.53547 \times 10^{-13}, 4 \rightarrow 1.\},$

4 859 584 663 297 976 265

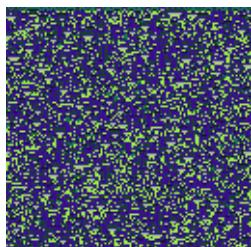

 $\rightarrow \{3 \rightarrow 1.23709 \times 10^{-23}, 4 \rightarrow 1.\},$

40 462 293 174 819 572 784

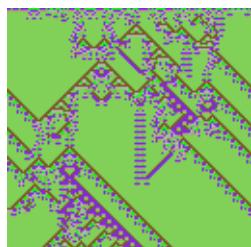

 $\rightarrow \{1 \rightarrow 4.45234 \times 10^{-14}, 2 \rightarrow 1.\}\}$

31 565 401 331 503 942 033

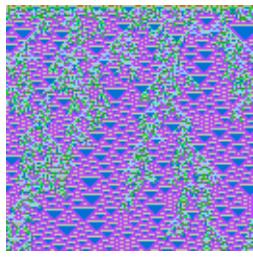
```
In[382]:= test4Data8kr1C18 = data8TC[8, 128, 128];
test4Data8kr1C18labeled = Thread[Labeled[
  Keys@test4Data8kr1C18, Values@test4Data8kr1C18, LabelStyle -> Small]];
Thread[test4Data8kr1C18labeled -> netECA18[Keys@test4Data8kr1C18,
 {"TopProbabilities", 2}]]
```


 $\rightarrow \{4 \rightarrow 1.29992 \times 10^{-6}, 3 \rightarrow 0.999999\},$

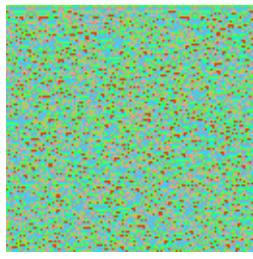
37 704 545 164 847 890 018


 $\rightarrow \{3 \rightarrow 9.65757 \times 10^{-15}, 4 \rightarrow 1.\},$

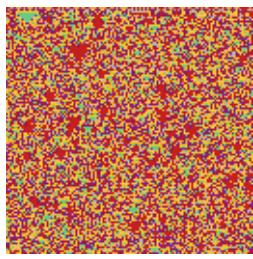
27 648 091 129 795 825 837


$$\rightarrow \{4 \rightarrow 3.23122 \times 10^{-6}, 3 \rightarrow 0.999997\},$$

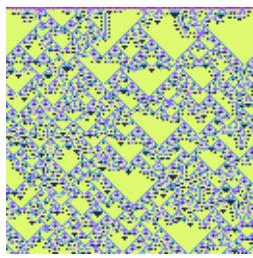
60 505 018 748 296 148 542


$$\rightarrow \{4 \rightarrow 3.09422 \times 10^{-6}, 3 \rightarrow 0.999997\},$$

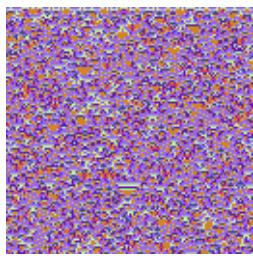
54 287 354 911 476 152 107


$$\rightarrow \{4 \rightarrow 1.61319 \times 10^{-13}, 3 \rightarrow 1.\},$$

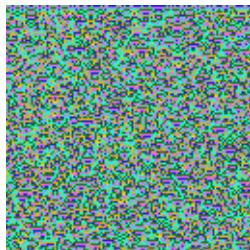
51 683 500 767 429 363 920


$$\rightarrow \{4 \rightarrow 0.0000932216, 3 \rightarrow 0.999907\},$$

41 609 680 851 379 694 800


$$\rightarrow \{4 \rightarrow 1.21235 \times 10^{-9}, 3 \rightarrow 1.\},$$

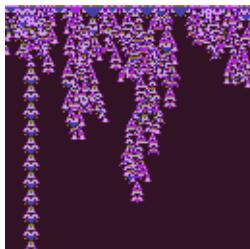
63 509 679 527 843 614 538



$\rightarrow \{4 \rightarrow 1.98827 \times 10^{-9}, 3 \rightarrow 1.\}\}$

6 460 427 784 035 907 917

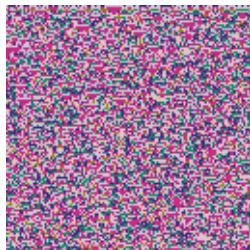
```
In[3659]:= test4Data8kr1C18 = data8TC[8, 128, 128];
test4Data8kr1C18labeled = Thread[Labeled[
  Keys@test4Data8kr1C18, Values@test4Data8kr1C18, LabelStyle -> Small]];
Thread[test4Data8kr1C18labeled -> netECA18[Keys@test4Data8kr1C18,
 {"TopProbabilities", 2}]]
```



$\rightarrow \{2 \rightarrow 1.31578 \times 10^{-18}, 4 \rightarrow 1.\},$

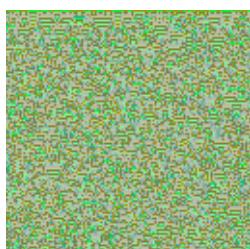
Out[3661]= {

73 032 271 117 848 209 243



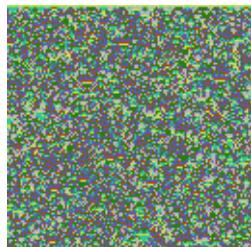
$\rightarrow \{3 \rightarrow 0.141446, 4 \rightarrow 0.858554\},$

39 978 387 518 629 221 822

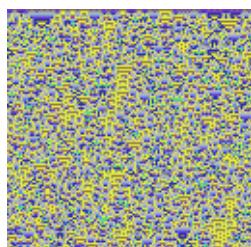


$\rightarrow \{4 \rightarrow 3.11573 \times 10^{-6}, 3 \rightarrow 0.999997\},$

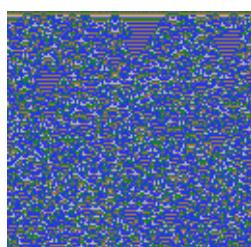
47 420 490 873 266 731 243


$$\rightarrow \{4 \rightarrow 1.89014 \times 10^{-10}, 3 \rightarrow 1.\},$$

69 178 595 154 763 873 748


$$\rightarrow \{4 \rightarrow 0.108677, 3 \rightarrow 0.891323\},$$

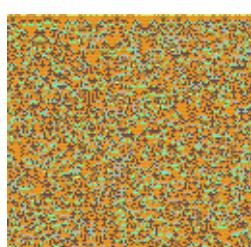
36 494 658 469 292 001 373


$$\rightarrow \{4 \rightarrow 1.30512 \times 10^{-7}, 3 \rightarrow 1.\},$$

44 633 438 881 696 619 809

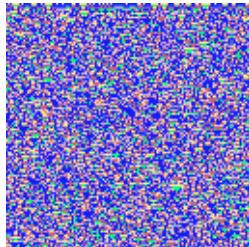

$$\rightarrow \{4 \rightarrow 5.20169 \times 10^{-9}, 3 \rightarrow 1.\},$$

16 597 694 124 357 617 042


$$\rightarrow \{4 \rightarrow 7.0756 \times 10^{-11}, 3 \rightarrow 1.\}\}$$

56 376 000 294 932 006 875

```
In[3682]:= test4Data8kr1C18 = data8TC[4, 128, 128];
test4Data8kr1C18labeled = Thread[Labeled[
  Keys@test4Data8kr1C18, Values@test4Data8kr1C18, LabelStyle -> Small]];
Thread[test4Data8kr1C18labeled -> netECA18[Keys@test4Data8kr1C18,
 {"TopProbabilities", 2}]]
```



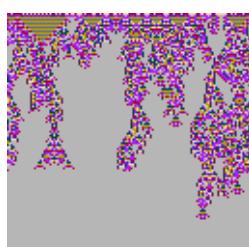
```
Out[3684]= {4 -> 0.120204, 3 -> 0.879796},
```

36 047 835 391 289 658 981



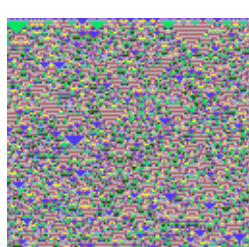
```
→ {4 -> 1.89351 × 10-14, 3 -> 1.},
```

12 886 947 894 941 941 653



```
→ {3 -> 2.94223 × 10-15, 4 -> 1.},
```

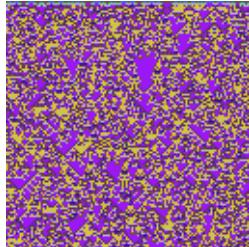
44 383 502 605 813 901 210



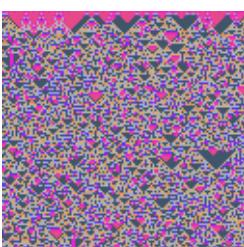
```
→ {4 -> 4.27651 × 10-15, 3 -> 1.} }
```

42 409 589 848 776 720 344

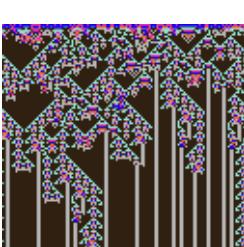
```
In[3690]:= test4Data8kr1C18 = data8TC[4, 128, 128];
test4Data8kr1C18labeled = Thread[Labeled[
  Keys@test4Data8kr1C18, Values@test4Data8kr1C18, LabelStyle -> Small]];
Thread[test4Data8kr1C18labeled -> netECA18[Keys@test4Data8kr1C18,
 {"TopProbabilities", 2}]]
```



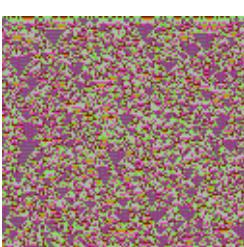
Out[3692]= $\{ \rightarrow \{3 \rightarrow 0.0743574, 4 \rightarrow 0.925643\},$



$\rightarrow \{4 \rightarrow 8.03074 \times 10^{-19}, 3 \rightarrow 1.\},$



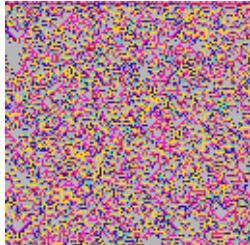
$\rightarrow \{2 \rightarrow 7.18656 \times 10^{-18}, 4 \rightarrow 1.\},$



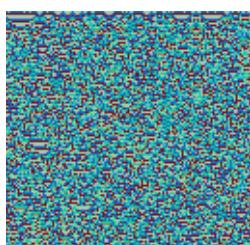
$\rightarrow \{4 \rightarrow 8.93277 \times 10^{-13}, 3 \rightarrow 1.\}\}$

32 531 401 704 565 982 539

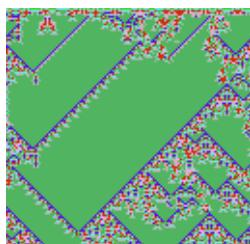
```
In[3708]:= test4Data8kr1C18 = data8TC[4, 128, 128];
test4Data8kr1C18labeled = Thread[Labeled[
  Keys@test4Data8kr1C18, Values@test4Data8kr1C18, LabelStyle -> Small]];
Thread[test4Data8kr1C18labeled -> netECA18[Keys@test4Data8kr1C18,
 {"TopProbabilities", 2}]]
```



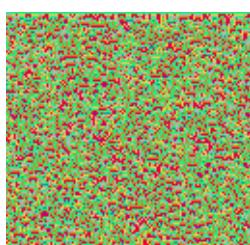
Out[3710]= $\{ \rightarrow \{4 \rightarrow 2.06397 \times 10^{-15}, 3 \rightarrow 1.\},$



$\rightarrow \{4 \rightarrow 0.0006615, 3 \rightarrow 0.999339\},$



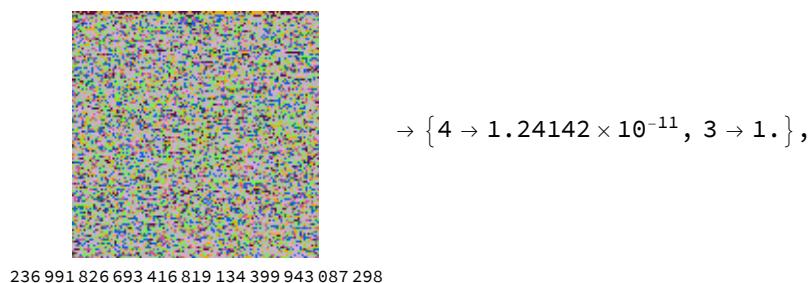
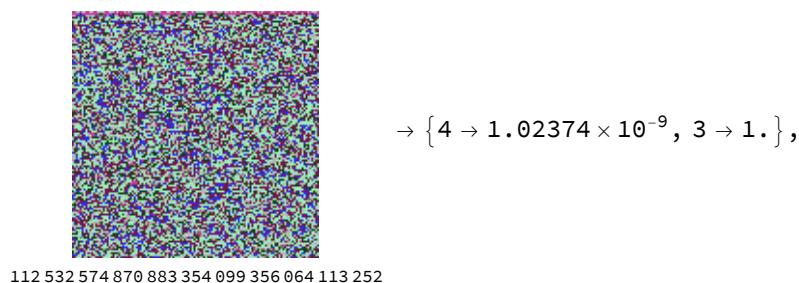
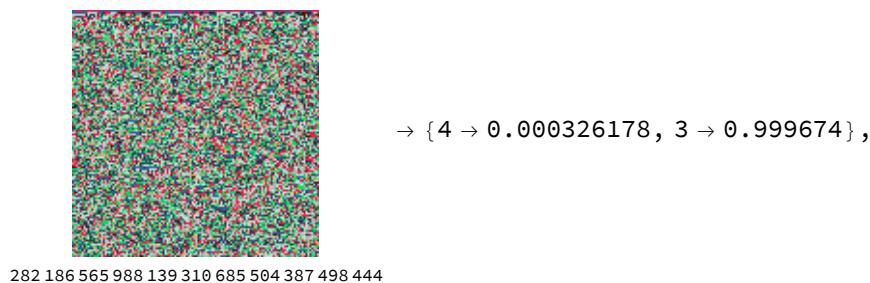
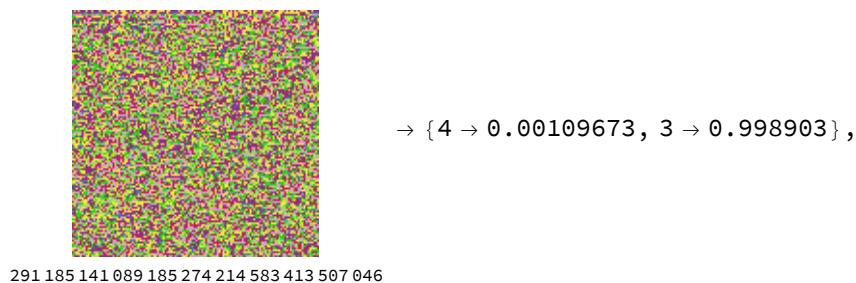
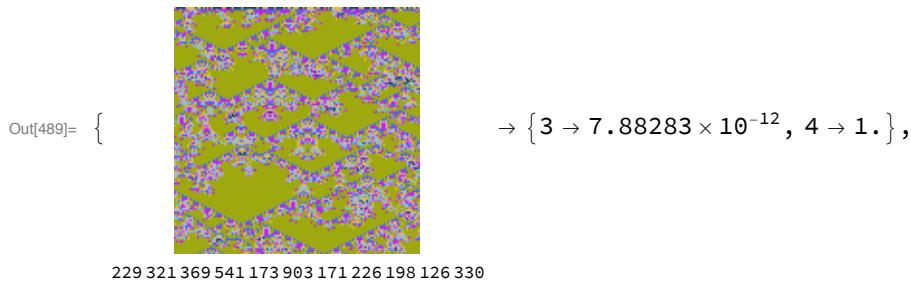
$\rightarrow \{3 \rightarrow 1.39682 \times 10^{-10}, 4 \rightarrow 1.\},$

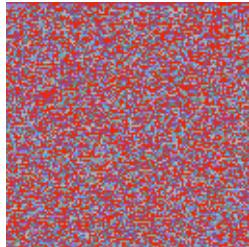


$\rightarrow \{4 \rightarrow 4.58237 \times 10^{-10}, 3 \rightarrow 1.\}\}$

8-colour totalistic, range 2

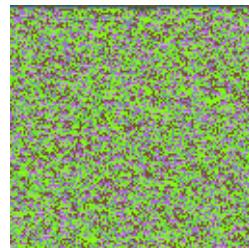
```
In[487]:= test4Data8kr2C18 = data8T2C[8, 128, 128];
test4Data8kr2C18labeled = Thread[Labeled[
  Keys@test4Data8kr2C18, Values@test4Data8kr2C18, LabelStyle -> Small]];
Thread[test4Data8kr2C18labeled -> netECA18[Keys@test4Data8kr2C18,
 {"TopProbabilities", 2}]]
```





63 680 569 239 782 716 398 778 656 016 965

$$\rightarrow \{4 \rightarrow 1.45662 \times 10^{-13}, 3 \rightarrow 1.\},$$



308 344 304 481 068 219 036 959 151 470 092

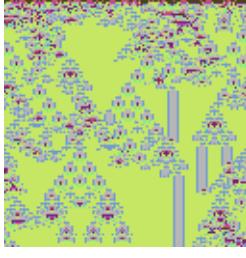
$$\rightarrow \{4 \rightarrow 6.68537 \times 10^{-7}, 3 \rightarrow 0.999999\},$$

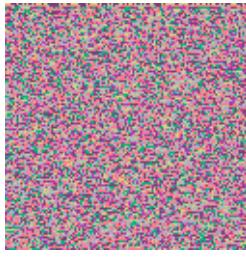


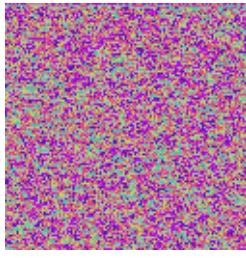
105 724 215 011 096 612 281 834 858 043 422

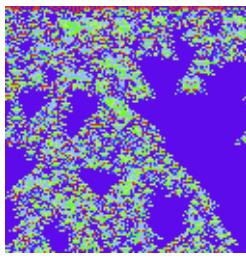
$$\rightarrow \{4 \rightarrow 1.57705 \times 10^{-8}, 3 \rightarrow 1.\}\}$$

```
In[3757]:= test4Data8kr2C18 = data8T2C[4, 128, 128];
test4Data8kr2C18labeled = Thread[Labeled[
  Keys@test4Data8kr2C18, Values@test4Data8kr2C18, LabelStyle -> Small]];
Thread[test4Data8kr2C18labeled -> netECA18[Keys@test4Data8kr2C18,
 {"TopProbabilities", 2}]]
```

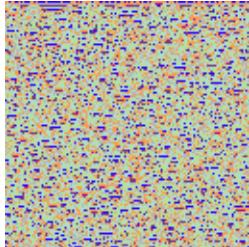
Out[3759]= 
 $\rightarrow \{3 \rightarrow 5.88913 \times 10^{-8}, 4 \rightarrow 1.\},$
155 047 897 388 743 938 334 318 256 953 557


 $\rightarrow \{4 \rightarrow 0.000171473, 3 \rightarrow 0.999829\},$
189 991 558 145 606 524 856 568 668 347 008


 $\rightarrow \{4 \rightarrow 2.38911 \times 10^{-8}, 3 \rightarrow 1.\},$
289 565 614 814 197 206 580 441 509 861 846

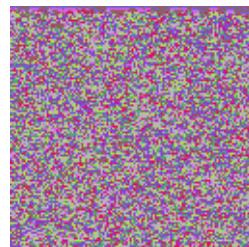

 $\rightarrow \{3 \rightarrow 3.01884 \times 10^{-11}, 4 \rightarrow 1.\}\}$
201 724 647 086 562 016 970 961 639 752 212

```
In[3884]:= test4Data8kr2C18 = data8T2C[4, 128, 128];
test4Data8kr2C18labeled = Thread[Labeled[
  Keys@test4Data8kr2C18, Values@test4Data8kr2C18, LabelStyle -> Small]];
Thread[test4Data8kr2C18labeled -> netECA18[Keys@test4Data8kr2C18,
 {"TopProbabilities", 2}]]
```



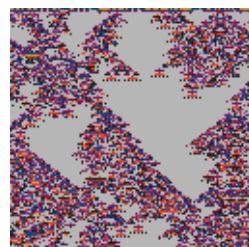
Out[3886]= $\{ \rightarrow \{4 \rightarrow 4.44873 \times 10^{-15}, 3 \rightarrow 1.\},$

39 297 940 037 607 076 008 618 831 045 266



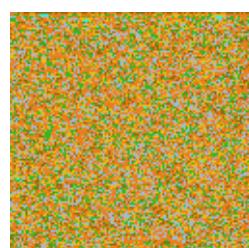
$\rightarrow \{4 \rightarrow 2.2457 \times 10^{-12}, 3 \rightarrow 1.\},$

146 709 149 570 773 063 178 319 041 692 377



$\rightarrow \{3 \rightarrow 1.52563 \times 10^{-13}, 4 \rightarrow 1.\},$

275 331 565 824 099 869 446 470 411 075 857

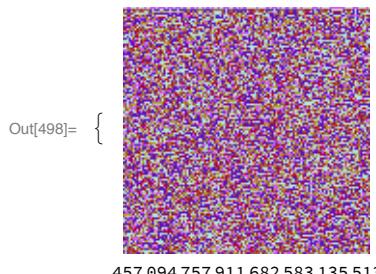
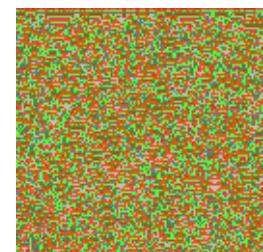
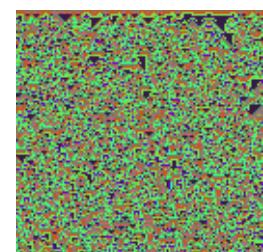
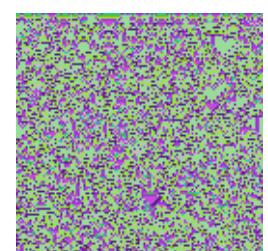
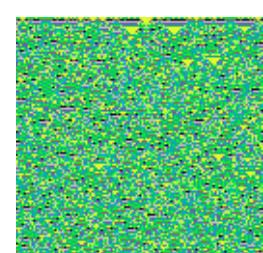


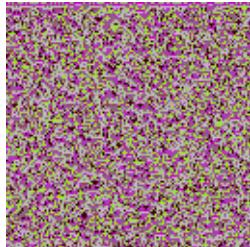
$\rightarrow \{4 \rightarrow 1.78644 \times 10^{-10}, 3 \rightarrow 1.\}\}$

159 257 701 877 009 243 816 390 931 143 951

9-colour totalistic, range 1

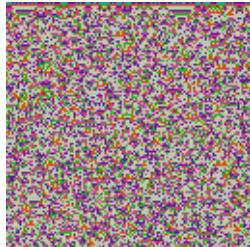
```
In[496]:= test4Data9kr1C18 = data9TC[8, 128, 128];
test4Data9kr1C18labeled = Thread[Labeled[
  Keys@test4Data9kr1C18, Values@test4Data9kr1C18, LabelStyle -> Small]];
Thread[test4Data9kr1C18labeled -> netECA18[Keys@test4Data9kr1C18,
 {"TopProbabilities", 2}]]
```

 $\rightarrow \{4 \rightarrow 5.83823 \times 10^{-9}, 3 \rightarrow 1.\},$  $\rightarrow \{4 \rightarrow 0.0000180204, 3 \rightarrow 0.999982\},$  $\rightarrow \{4 \rightarrow 4.45654 \times 10^{-7}, 3 \rightarrow 1.\},$  $\rightarrow \{4 \rightarrow 8.57981 \times 10^{-11}, 3 \rightarrow 1.\},$  $\rightarrow \{4 \rightarrow 2.43131 \times 10^{-7}, 3 \rightarrow 1.\},$



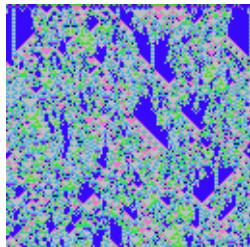
$$\rightarrow \{4 \rightarrow 1.51658 \times 10^{-8}, 3 \rightarrow 1.\},$$

433 148 230 728 762 736 100 900



$$\rightarrow \{4 \rightarrow 6.70076 \times 10^{-10}, 3 \rightarrow 1.\},$$

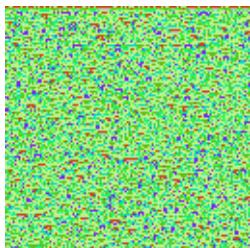
396 827 895 882 577 775 438 185



$$\rightarrow \{2 \rightarrow 4.02659 \times 10^{-6}, 4 \rightarrow 0.999996\}\}$$

351 429 815 695 311 172 396 620

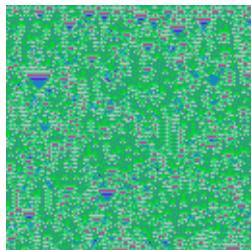
```
In[511]:= test4Data9kr1C18 = data9TC[8, 128, 128];
test4Data9kr1C18labeled = Thread[Labeled[
  Keys@test4Data9kr1C18, Values@test4Data9kr1C18, LabelStyle -> Small]];
Thread[test4Data9kr1C18labeled -> netECA18[Keys@test4Data9kr1C18,
 {"TopProbabilities", 2}]]
```



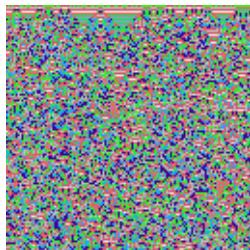
$$\rightarrow \{4 \rightarrow 2.58219 \times 10^{-8}, 3 \rightarrow 1.\},$$

Out[513]= {

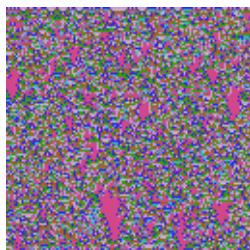
571 898 225 263 709 171 935 181


$$\rightarrow \{4 \rightarrow 4.17492 \times 10^{-16}, 3 \rightarrow 1.\},$$

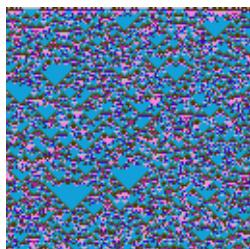
16 416 436 883 866 903 040 539


$$\rightarrow \{4 \rightarrow 6.31934 \times 10^{-11}, 3 \rightarrow 1.\},$$

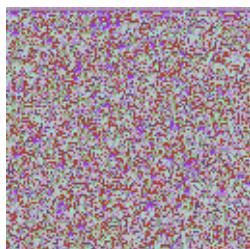
505 080 187 994 424 945 599 908


$$\rightarrow \{3 \rightarrow 9.02887 \times 10^{-6}, 4 \rightarrow 0.999991\},$$

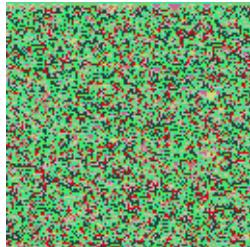
405 543 563 336 574 719 930 798


$$\rightarrow \{4 \rightarrow 1.01538 \times 10^{-9}, 3 \rightarrow 1.\},$$

640 899 150 274 978 311 294 101

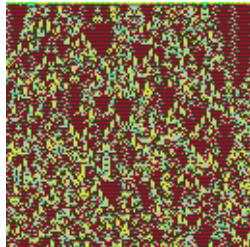

$$\rightarrow \{4 \rightarrow 1.45824 \times 10^{-11}, 3 \rightarrow 1.\},$$

477 880 861 207 247 090 323 396



$\rightarrow \{4 \rightarrow 9.03987 \times 10^{-7}, 3 \rightarrow 0.999999\},$

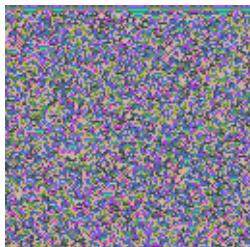
356 314 942 681 551 111 282 584



$\rightarrow \{3 \rightarrow 0.000582645, 4 \rightarrow 0.999417\}$

298 013 848 612 651 157 159 625

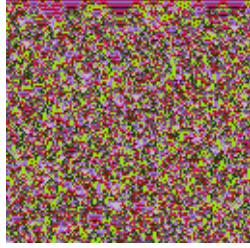
```
In[517]:= test4Data9kr1C18 = data9TC[8, 128, 128];
test4Data9kr1C18labeled = Thread[Labeled[
  Keys@test4Data9kr1C18, Values@test4Data9kr1C18, LabelStyle -> Small]];
Thread[test4Data9kr1C18labeled -> netECA18[Keys@test4Data9kr1C18,
 {"TopProbabilities", 2}]]
```



$\rightarrow \{4 \rightarrow 1.13815 \times 10^{-9}, 3 \rightarrow 1.\},$

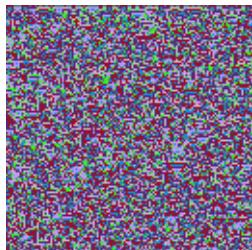
Out[519]= {

404 972 488 645 689 700 322 864

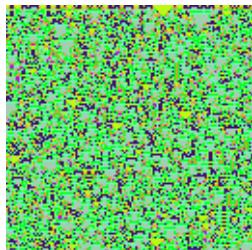


$\rightarrow \{4 \rightarrow 3.0794 \times 10^{-6}, 3 \rightarrow 0.999997\},$

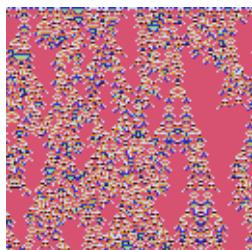
156 272 014 430 518 577 617 637


$$\rightarrow \{ 4 \rightarrow 3.81028 \times 10^{-10}, 3 \rightarrow 1. \},$$

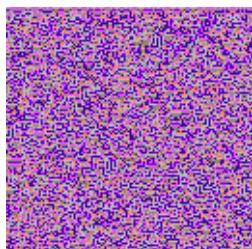
284 513 558 853 107 156 814 399


$$\rightarrow \{ 4 \rightarrow 3.3638 \times 10^{-20}, 3 \rightarrow 1. \},$$

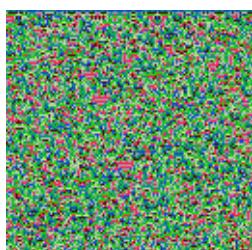
267 248 041 318 669 677 071 928


$$\rightarrow \{ 3 \rightarrow 5.54447 \times 10^{-10}, 4 \rightarrow 1. \},$$

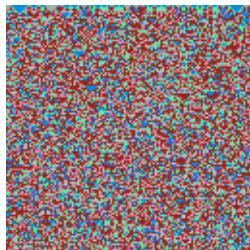
153 914 863 772 284 089 057 679


$$\rightarrow \{ 4 \rightarrow 1.13692 \times 10^{-9}, 3 \rightarrow 1. \},$$

254 141 771 646 448 052 827 109


$$\rightarrow \{ 4 \rightarrow 5.3356 \times 10^{-12}, 3 \rightarrow 1. \},$$

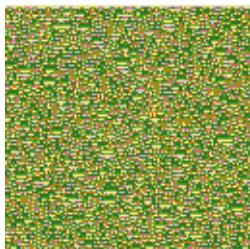
404 793 401 643 156 100 738 375



$\rightarrow \{4 \rightarrow 6.60115 \times 10^{-9}, 3 \rightarrow 1.\}\}$

670 268 613 476 400 266 631 186

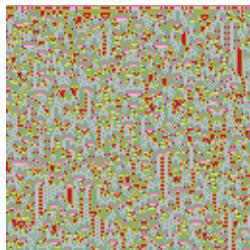
```
In[523]:= test4Data9kr1C18 = data9TC[8, 128, 128];
test4Data9kr1C18labeled = Thread[Labeled[
  Keys@test4Data9kr1C18, Values@test4Data9kr1C18, LabelStyle -> Small]];
Thread[test4Data9kr1C18labeled -> netECA18[Keys@test4Data9kr1C18,
  {"TopProbabilities", 2}]]
```



$\rightarrow \{4 \rightarrow 2.4276 \times 10^{-9}, 3 \rightarrow 1.\},$

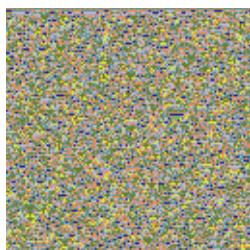
Out[525]= {

355 971 169 427 388 040 424 582



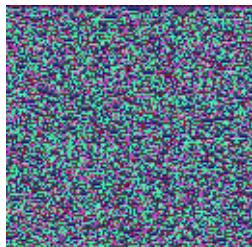
$\rightarrow \{3 \rightarrow 0.059592, 4 \rightarrow 0.940408\},$

533 897 222 146 305 160 363 448

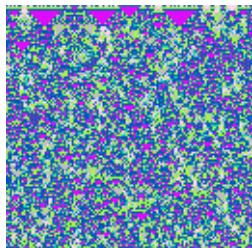


$\rightarrow \{4 \rightarrow 2.29648 \times 10^{-11}, 3 \rightarrow 1.\},$

691 506 306 126 519 782 511 638

 $\rightarrow \{ 4 \rightarrow 0.0929386, 3 \rightarrow 0.907061 \},$

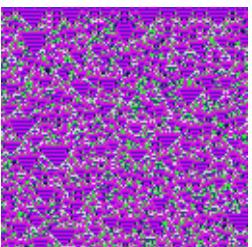
323 208 263 876 392 814 574 412

 $\rightarrow \{ 4 \rightarrow 7.66009 \times 10^{-12}, 3 \rightarrow 1. \},$

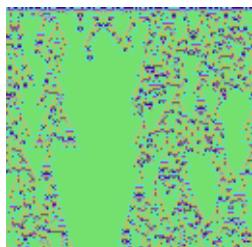
616 227 181 029 580 959 691 458

 $\rightarrow \{ 4 \rightarrow 6.44332 \times 10^{-9}, 3 \rightarrow 1. \},$

190 650 889 368 707 191 921 149

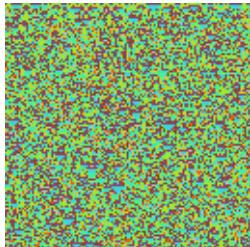
 $\rightarrow \{ 4 \rightarrow 1.31887 \times 10^{-21}, 3 \rightarrow 1. \},$

73 319 162 863 689 362 047 643

 $\rightarrow \{ 3 \rightarrow 6.58991 \times 10^{-13}, 4 \rightarrow 1. \} \}$

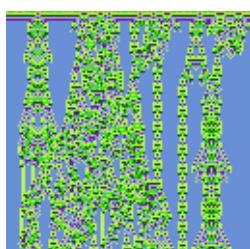
287 724 570 221 091 851 404 918

```
In[4183]:= test4Data9kr1C18 = data9TC[4, 128, 128];
test4Data9kr1C18labeled = Thread[Labeled[
  Keys@test4Data9kr1C18, Values@test4Data9kr1C18, LabelStyle -> Small]];
Thread[test4Data9kr1C18labeled -> netECA18[Keys@test4Data9kr1C18,
  {"TopProbabilities", 2}]]
```



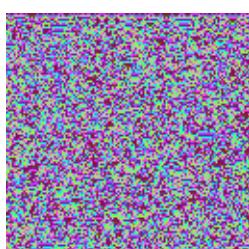
```
Out[4185]= {
```

$$\rightarrow \{4 \rightarrow 2.09693 \times 10^{-7}, 3 \rightarrow 1.\},$$



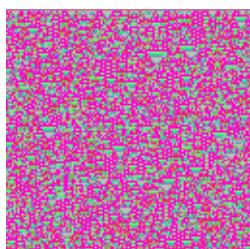
$$\rightarrow \{3 \rightarrow 4.58502 \times 10^{-27}, 4 \rightarrow 1.\},$$

```
573 761 719 825 334 448 979 062
```



$$\rightarrow \{4 \rightarrow 0.0000484419, 3 \rightarrow 0.999952\},$$

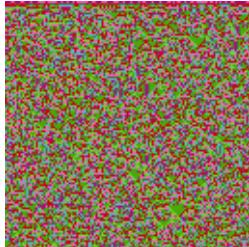
```
6 790 893 480 501 123 950 656
```



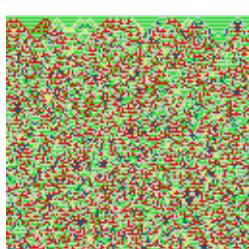
$$\rightarrow \{4 \rightarrow 4.33425 \times 10^{-10}, 3 \rightarrow 1.\}\}$$

```
473 676 743 599 008 161 910 266
```

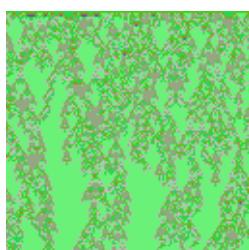
```
In[4222]:= test4Data9kr1C18 = data9TC[4, 128, 128];
test4Data9kr1C18labeled = Thread[Labeled[
  Keys@test4Data9kr1C18, Values@test4Data9kr1C18, LabelStyle -> Small]];
Thread[test4Data9kr1C18labeled -> netECA18[Keys@test4Data9kr1C18,
 {"TopProbabilities", 2}]]
```



Out[4224]= $\{ \rightarrow \{4 \rightarrow 4.32562 \times 10^{-17}, 3 \rightarrow 1. \} ,$

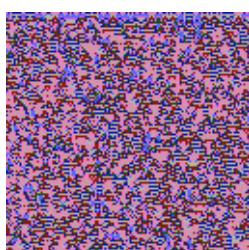


234 987 596 698 753 802 801 090



$\rightarrow \{3 \rightarrow 1.78645 \times 10^{-15}, 4 \rightarrow 1. \} ,$

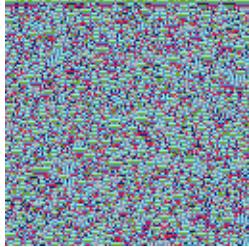
517 053 527 698 050 805 653 198



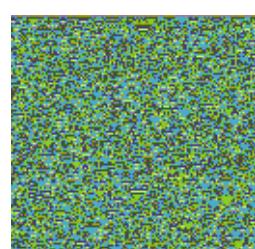
$\rightarrow \{4 \rightarrow 1.52533 \times 10^{-10}, 3 \rightarrow 1. \} \}$

259 628 110 102 041 518 916 677

```
In[4247]:= test4Data9kr1C18 = data9TC[4, 128, 128];
test4Data9kr1C18labeled = Thread[Labeled[
  Keys@test4Data9kr1C18, Values@test4Data9kr1C18, LabelStyle -> Small]];
Thread[test4Data9kr1C18labeled -> netECA18[Keys@test4Data9kr1C18,
 {"TopProbabilities", 2}]]
```

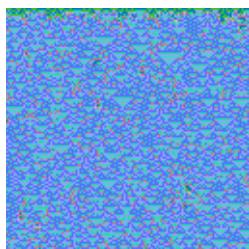


Out[4249]= $\{ \rightarrow \{4 \rightarrow 3.00043 \times 10^{-9}, 3 \rightarrow 1.\},$
41 897 772 483 159 633 262 219



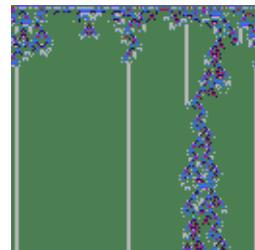
$\rightarrow \{4 \rightarrow 7.71986 \times 10^{-8}, 3 \rightarrow 1.\},$

610 126 206 764 477 591 654 962



$\rightarrow \{4 \rightarrow 1.0725 \times 10^{-11}, 3 \rightarrow 1.\},$

32 034 792 209 849 172 674 035

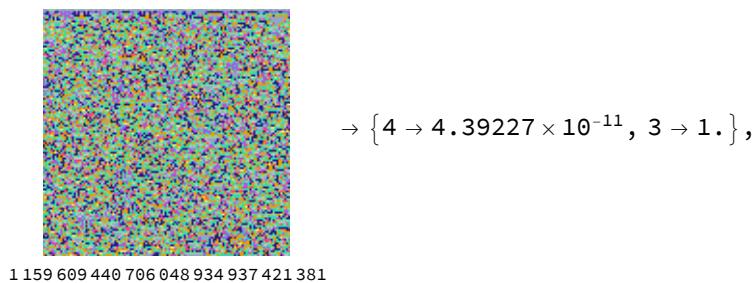
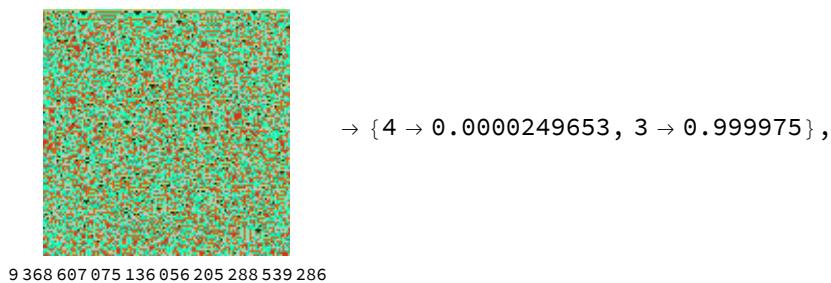
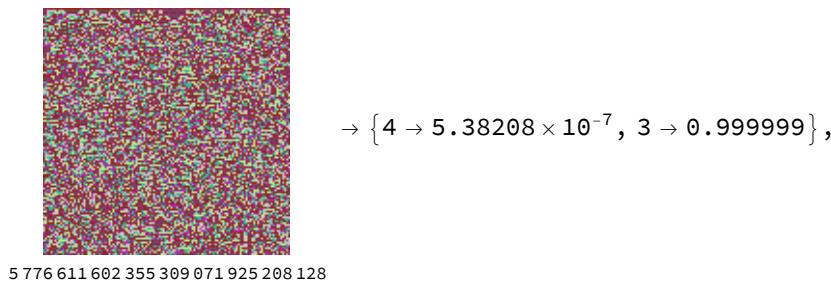
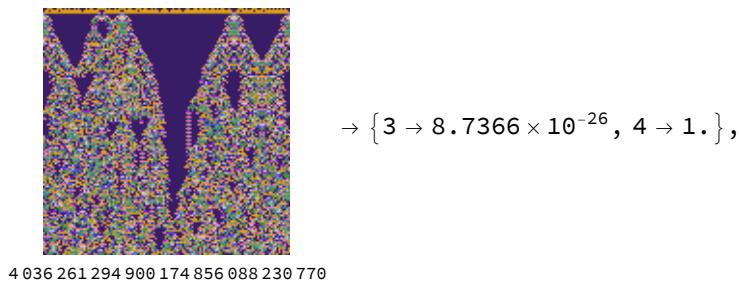
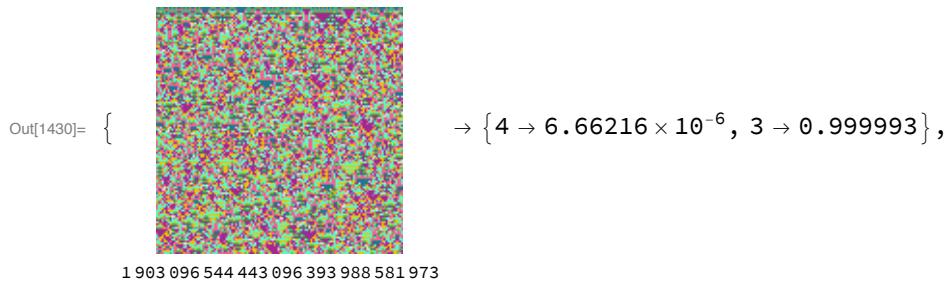


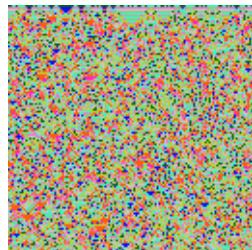
$\rightarrow \{3 \rightarrow 6.1596 \times 10^{-22}, 4 \rightarrow 1.\}\}$

273 991 692 493 747 611 945 929

10-colour totalistic, range 1

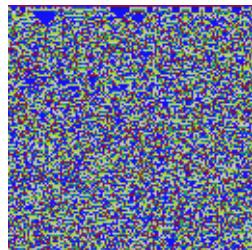
```
In[1428]:= test4Data10kr1C18 = data10TC[8, 128, 128];
test4Data10kr1C18labeled = Thread[Labeled[
  Keys@test4Data10kr1C18, Values@test4Data10kr1C18, LabelStyle -> Small]];
Thread[test4Data10kr1C18labeled -> netECA18[Keys@test4Data10kr1C18,
 {"TopProbabilities", 2}]]
```





$\rightarrow \{4 \rightarrow 0.0000298941, 3 \rightarrow 0.99997\},$

9 585 758 006 399 290 542 154 306 334



$\rightarrow \{4 \rightarrow 8.01368 \times 10^{-14}, 3 \rightarrow 1.\},$

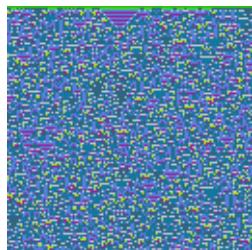
7 176 425 566 624 142 460 503 296 528



$\rightarrow \{4 \rightarrow 2.83049 \times 10^{-14}, 3 \rightarrow 1.\}\}$

3 224 320 499 780 698 506 582 500 278

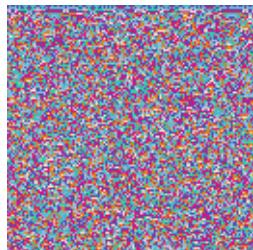
```
In[2869]:= test4Data10kr1C18 = data10TC[8, 128, 128];
test4Data10kr1C18labeled = Thread[Labeled[
  Keys@test4Data10kr1C18, Values@test4Data10kr1C18, LabelStyle -> Small]];
Thread[test4Data10kr1C18labeled -> netECA18[Keys@test4Data10kr1C18,
 {"TopProbabilities", 2}]]
```



$\rightarrow \{4 \rightarrow 1.58131 \times 10^{-9}, 3 \rightarrow 1.\},$

Out[2871]= {

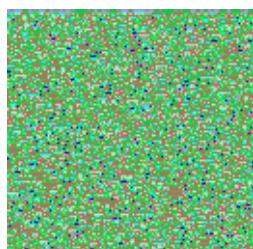
5 199 627 926 769 656 375 447 627 688

 $\rightarrow \{4 \rightarrow 0.000263972, 3 \rightarrow 0.999736\},$

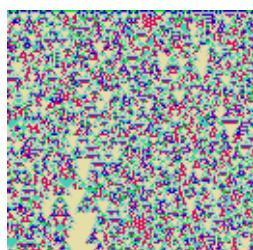
3 280 011 279 820 970 114 546 938 087

 $\rightarrow \{4 \rightarrow 1.35049 \times 10^{-11}, 3 \rightarrow 1.\},$

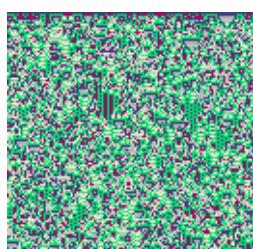
9 890 013 257 778 978 449 014 421 805

 $\rightarrow \{4 \rightarrow 0.0000658741, 3 \rightarrow 0.999934\},$

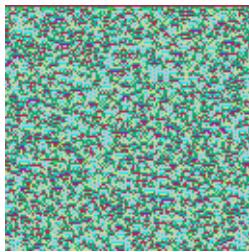
8 501 514 075 032 747 643 488 945 170

 $\rightarrow \{3 \rightarrow 6.84714 \times 10^{-17}, 4 \rightarrow 1.\},$

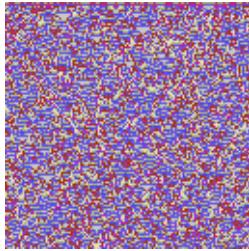
6 368 250 822 034 213 483 385 943 072

 $\rightarrow \{4 \rightarrow 9.94861 \times 10^{-9}, 3 \rightarrow 1.\},$

8 122 219 163 058 531 337 652 077 374

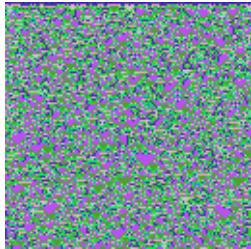

 $\rightarrow \{4 \rightarrow 3.35918 \times 10^{-9}, 3 \rightarrow 1.\},$

9 172 300 148 102 056 224 623 052 592


 $\rightarrow \{4 \rightarrow 5.30505 \times 10^{-8}, 3 \rightarrow 1.\}\}$

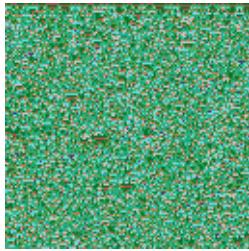
9 932 712 060 982 807 087 482 783 418

```
In[2878]:= test4Data10kr1C18 = data10TC[8, 128, 128];
test4Data10kr1C18labeled = Thread[Labeled[
  Keys@test4Data10kr1C18, Values@test4Data10kr1C18, LabelStyle -> Small]];
Thread[test4Data10kr1C18labeled -> netECA18[Keys@test4Data10kr1C18,
 {"TopProbabilities", 2}]]
```

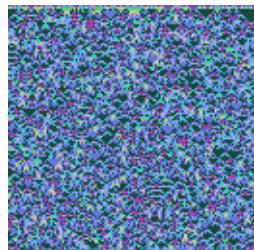

 $\rightarrow \{4 \rightarrow 2.12401 \times 10^{-19}, 3 \rightarrow 1.\},$

Out[2880]= {

483 437 276 696 906 907 442 394 303


 $\rightarrow \{4 \rightarrow 0.0000103518, 3 \rightarrow 0.99999\},$

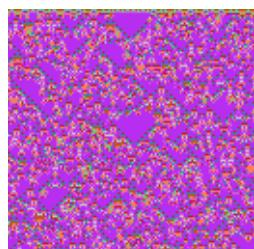
6 248 862 755 341 623 974 391 160 671


$$\rightarrow \{4 \rightarrow 5.14429 \times 10^{-10}, 3 \rightarrow 1.\},$$

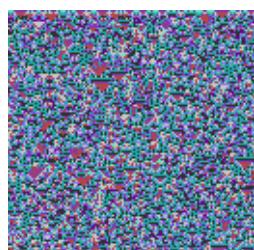
1 708 131 558 685 652 694 884 861 230


$$\rightarrow \{4 \rightarrow 1.68736 \times 10^{-6}, 3 \rightarrow 0.999998\},$$

3 785 405 685 171 157 920 474 254 860


$$\rightarrow \{3 \rightarrow 0.451616, 4 \rightarrow 0.548384\},$$

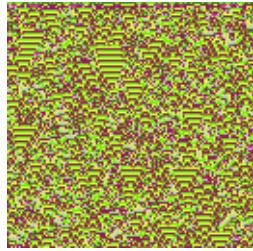
4 941 095 623 575 584 457 015 934 079


$$\rightarrow \{4 \rightarrow 9.78771 \times 10^{-13}, 3 \rightarrow 1.\},$$

2 415 498 661 256 559 123 932 103 254


$$\rightarrow \{2 \rightarrow 4.31849 \times 10^{-13}, 4 \rightarrow 1.\},$$

3 338 238 558 742 348 917 885 667 755

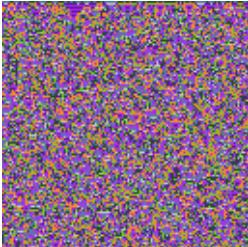


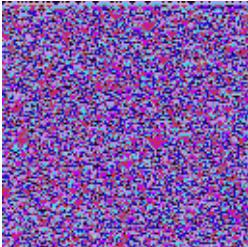
$\rightarrow \{4 \rightarrow 0.00877728, 3 \rightarrow 0.991223\}$ }

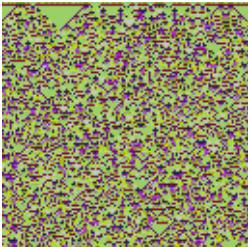
1 806 423 763 631 239 621 190 376 486

```
In[4272]:= test4Data10kr1C18 = data10TC[4, 128, 128];
test4Data10kr1C18labeled = Thread[Labeled[
  Keys@test4Data10kr1C18, Values@test4Data10kr1C18, LabelStyle -> Small]];
Thread[test4Data10kr1C18labeled -> netECA18[Keys@test4Data10kr1C18,
 {"TopProbabilities", 2}]]
```

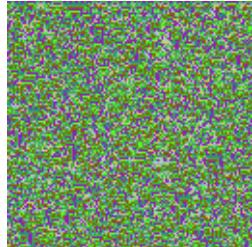
Out[4274]= $\left\{ \begin{array}{l} \text{A fractal-like triangular pattern composed of small colored dots on a dark background.} \\ \rightarrow \{3 \rightarrow 8.23252 \times 10^{-14}, 4 \rightarrow 1.\} , \\ 716604555055695263414034458 \end{array} \right.$


 $\rightarrow \{4 \rightarrow 2.65525 \times 10^{-6}, 3 \rightarrow 0.999997\} ,$
1744691624061938169045032863


 $\rightarrow \{4 \rightarrow 2.50446 \times 10^{-10}, 3 \rightarrow 1.\} ,$
8734633780649349518163797624

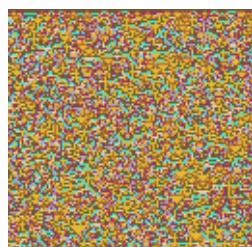

 $\rightarrow \{4 \rightarrow 1.21673 \times 10^{-17}, 3 \rightarrow 1.\} \}$
3027235191198450010062507330

```
In[4321]:= test4Data10kr1C18 = data10TC[4, 128, 128];
test4Data10kr1C18labeled = Thread[Labeled[
  Keys@test4Data10kr1C18, Values@test4Data10kr1C18, LabelStyle -> Small]];
Thread[test4Data10kr1C18labeled -> netECA18[Keys@test4Data10kr1C18,
 {"TopProbabilities", 2}]]
```



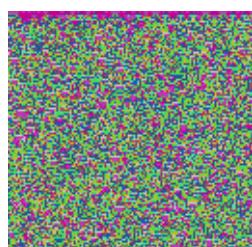
Out[4323]= $\{ \rightarrow \{4 \rightarrow 2.64238 \times 10^{-6}, 3 \rightarrow 0.999997\},$

5 440 618 768 118 696 205 010 470 947



$\rightarrow \{4 \rightarrow 5.71609 \times 10^{-10}, 3 \rightarrow 1.\},$

2 257 087 568 987 050 464 970 073 584



$\rightarrow \{4 \rightarrow 2.09356 \times 10^{-8}, 3 \rightarrow 1.\},$

8 134 292 633 848 677 039 161 625 080



$\rightarrow \{3 \rightarrow 0.175264, 4 \rightarrow 0.824736\}$

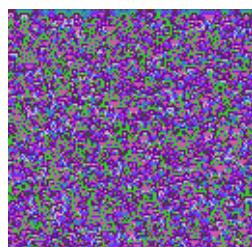
6 068 340 453 601 222 979 979 999 842

```
In[4337]:= test4Data10kr1C18 = data10TC[4, 128, 128];
test4Data10kr1C18labeled = Thread[Labeled[
  Keys@test4Data10kr1C18, Values@test4Data10kr1C18, LabelStyle -> Small]];
Thread[test4Data10kr1C18labeled -> netECA18[Keys@test4Data10kr1C18,
 {"TopProbabilities", 2}]]
```



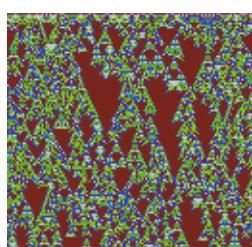
Out[4339]= $\{ \rightarrow \{4 \rightarrow 9.63686 \times 10^{-7}, 3 \rightarrow 0.999999\},$

5 163 570 425 210 666 610 374 293 512



$\rightarrow \{4 \rightarrow 2.299 \times 10^{-6}, 3 \rightarrow 0.999998\},$

3 134 969 094 935 364 132 691 979 163



$\rightarrow \{3 \rightarrow 1.46746 \times 10^{-12}, 4 \rightarrow 1.\},$

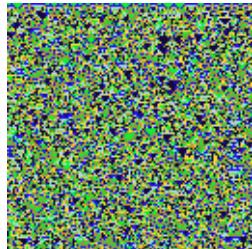
576 348 367 426 434 976 742 388 629



$\rightarrow \{4 \rightarrow 1.4474 \times 10^{-10}, 3 \rightarrow 1.\}\}$

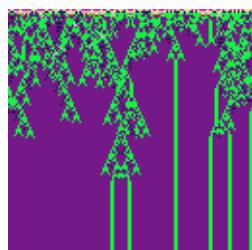
713 638 904 043 237 158 762 752 163

```
In[4371]:= test4Data10kr1C18 = data10TC[4, 128, 128];
test4Data10kr1C18labeled = Thread[Labeled[
  Keys@test4Data10kr1C18, Values@test4Data10kr1C18, LabelStyle -> Small]];
Thread[test4Data10kr1C18labeled -> netECA18[Keys@test4Data10kr1C18,
 {"TopProbabilities", 2}]]
```



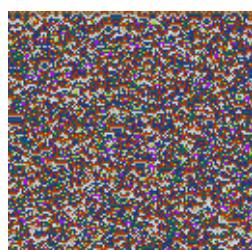
Out[4373]= $\{ \rightarrow \{4 \rightarrow 5.12919 \times 10^{-7}, 3 \rightarrow 0.999999\},$

5 907 348 376 691 063 450 175 537 410



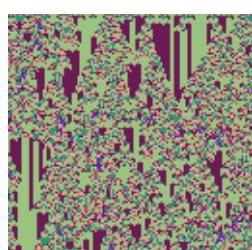
$\rightarrow \{2 \rightarrow 1.02857 \times 10^{-20}, 4 \rightarrow 1.\},$

9 459 936 993 737 293 686 768 142 512



$\rightarrow \{4 \rightarrow 0.000114206, 3 \rightarrow 0.999886\},$

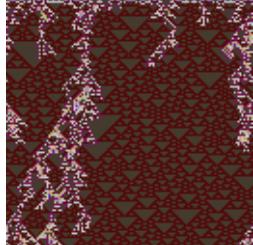
5 557 773 575 244 591 116 435 220 506



$\rightarrow \{3 \rightarrow 8.1511 \times 10^{-10}, 4 \rightarrow 1.\}\}$

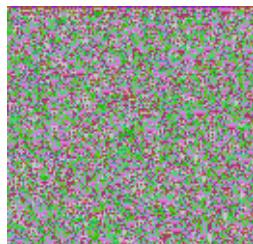
2 709 432 596 115 461 851 140 851 654

```
In[4395]:= test4Data10kr1C18 = data10TC[4, 128, 128];
test4Data10kr1C18labeled = Thread[Labeled[
  Keys@test4Data10kr1C18, Values@test4Data10kr1C18, LabelStyle -> Small]];
Thread[test4Data10kr1C18labeled -> netECA18[Keys@test4Data10kr1C18,
 {"TopProbabilities", 2}]]
```



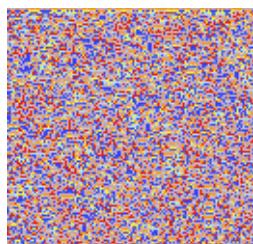
Out[4397]= $\{ \rightarrow \{3 \rightarrow 1.40688 \times 10^{-19}, 4 \rightarrow 1.\},$

2 410 559 128 621 742 741 231 341 231



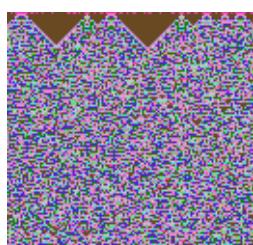
$\rightarrow \{4 \rightarrow 3.71853 \times 10^{-11}, 3 \rightarrow 1.\},$

9 394 567 383 394 731 265 724 852 139



$\rightarrow \{4 \rightarrow 2.20547 \times 10^{-7}, 3 \rightarrow 1.\},$

3 552 666 754 910 005 088 477 802 941

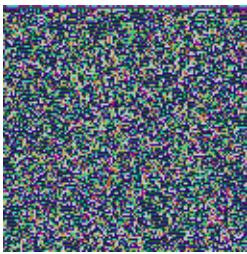


$\rightarrow \{4 \rightarrow 3.02409 \times 10^{-15}, 3 \rightarrow 1.\}\}$

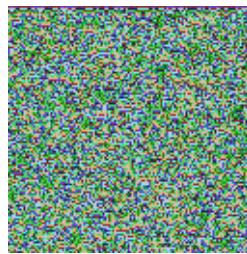
8 752 931 485 044 123 676 629 841 115

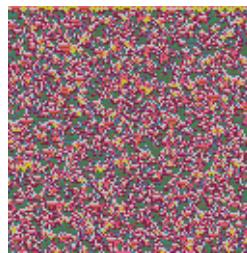
11-colour totalistic, range 1

```
In[1440]:= test4Data11kr1C18 = data11TC[8, 128, 128];
test4Data11kr1C18labeled = Thread[Labeled[
  Keys@test4Data11kr1C18, Values@test4Data11kr1C18, LabelStyle -> Small]];
Thread[test4Data11kr1C18labeled -> netECA18[Keys@test4Data11kr1C18,
 {"TopProbabilities", 2}]]
```

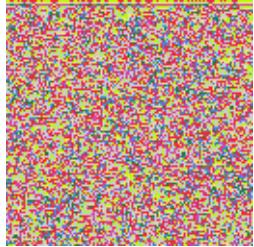
Out[1442]= 
 $\rightarrow \{4 \rightarrow 9.41752 \times 10^{-9}, 3 \rightarrow 1.\},$
27 602 157 973 840 641 007 105 652 106 671

Out[1443]= 
 $\rightarrow \{2 \rightarrow 1.96872 \times 10^{-15}, 4 \rightarrow 1.\},$
9 422 428 048 625 511 295 094 670 912 285

Out[1444]= 
 $\rightarrow \{4 \rightarrow 1.70571 \times 10^{-6}, 3 \rightarrow 0.999998\},$
152 007 042 234 913 357 388 586 460 753 588

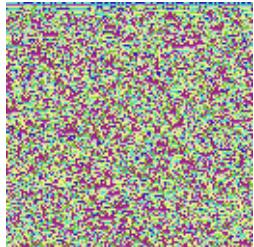
Out[1445]= 
 $\rightarrow \{4 \rightarrow 3.79533 \times 10^{-12}, 3 \rightarrow 1.\},$
177 741 547 512 091 115 527 598 027 282 597

Out[1446]= 
 $\rightarrow \{4 \rightarrow 2.11903 \times 10^{-11}, 3 \rightarrow 1.\},$
6 410 005 958 600 172 029 712 985 812 034



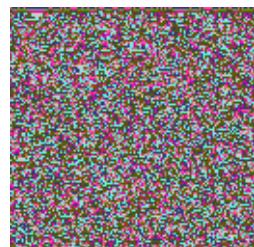
$\rightarrow \{4 \rightarrow 0.0000280034, 3 \rightarrow 0.999972\},$

62 674 162 164 599 079 657 718 948 002 220



$\rightarrow \{4 \rightarrow 0.000625919, 3 \rightarrow 0.999374\},$

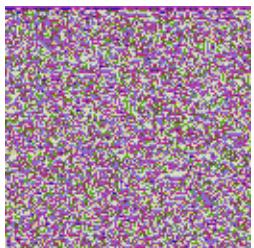
54 565 635 982 317 707 368 048 715 194 998



$\rightarrow \{4 \rightarrow 0.0318018, 3 \rightarrow 0.968198\}\}$

106 166 310 463 190 697 380 502 476 410 631

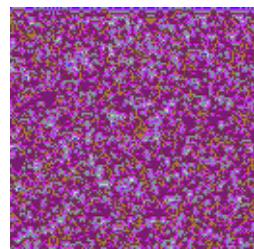
```
In[2854]:= test4Data11kr1C18 = data11TC[8, 128, 128];
test4Data11kr1C18labeled = Thread[Labeled[
  Keys@test4Data11kr1C18, Values@test4Data11kr1C18, LabelStyle -> Small]];
Thread[test4Data11kr1C18labeled -> netECA18[Keys@test4Data11kr1C18,
 {"TopProbabilities", 2}]]
```



$\rightarrow \{4 \rightarrow 3.16379 \times 10^{-7}, 3 \rightarrow 1.\},$

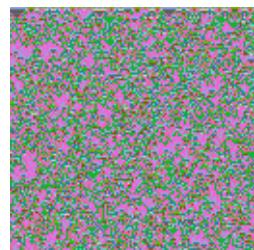
Out[2856]= {

29 820 750 454 785 368 367 022 551 930 565



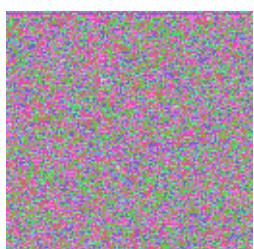
181 032 225 072 361 375 185 828 818 717 400

$$\rightarrow \{4 \rightarrow 3.43337 \times 10^{-18}, 3 \rightarrow 1.\},$$



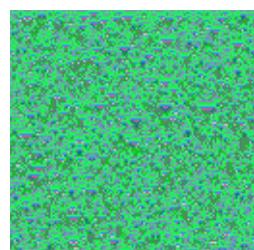
108 343 176 022 819 942 595 867 560 333 871

$$\rightarrow \{4 \rightarrow 2.28938 \times 10^{-6}, 3 \rightarrow 0.999998\},$$



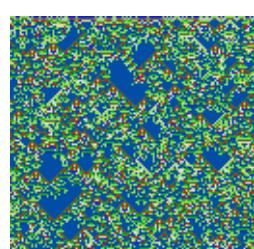
83 597 605 048 994 495 396 486 564 917 843

$$\rightarrow \{4 \rightarrow 1.04878 \times 10^{-7}, 3 \rightarrow 1.\},$$



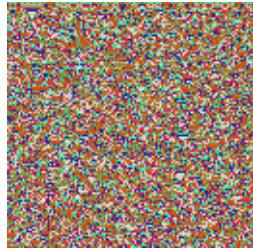
104 912 724 915 567 220 210 455 820 255 984

$$\rightarrow \{4 \rightarrow 3.25081 \times 10^{-8}, 3 \rightarrow 1.\},$$



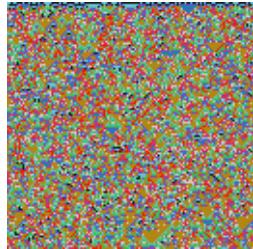
128 497 224 185 961 679 762 644 510 882 013

$$\rightarrow \{3 \rightarrow 1.21787 \times 10^{-17}, 4 \rightarrow 1.\},$$



$\rightarrow \{4 \rightarrow 4.18301 \times 10^{-7}, 3 \rightarrow 1.\},$

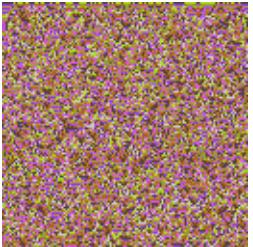
144 527 454 847 595 826 713 305 757 809 533



$\rightarrow \{4 \rightarrow 3.35665 \times 10^{-13}, 3 \rightarrow 1.\}\}$

151 862 481 481 457 968 853 308 246 579 641

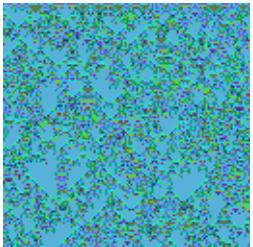
```
In[2866]:= test4Data11kr1C18 = data11TC[8, 128, 128];
test4Data11kr1C18labeled = Thread[Labeled[
  Keys@test4Data11kr1C18, Values@test4Data11kr1C18, LabelStyle -> Small]];
Thread[test4Data11kr1C18labeled -> netECA18[Keys@test4Data11kr1C18,
 {"TopProbabilities", 2}]]
```



$\rightarrow \{4 \rightarrow 5.0476 \times 10^{-11}, 3 \rightarrow 1.\},$

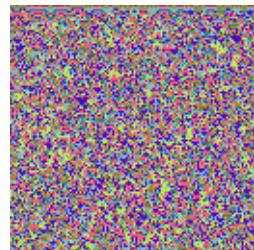
Out[2868]= {

81 707 296 083 455 701 758 264 527 074 128



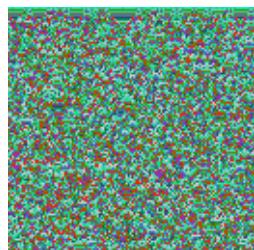
$\rightarrow \{3 \rightarrow 0.139159, 4 \rightarrow 0.860841\},$

69 618 595 000 243 088 520 204 183 973 564



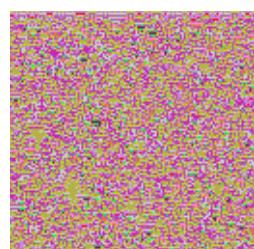
148 992 607 202 005 963 064 038 639 239 963

$$\rightarrow \{4 \rightarrow 2.33649 \times 10^{-6}, 3 \rightarrow 0.999998\},$$



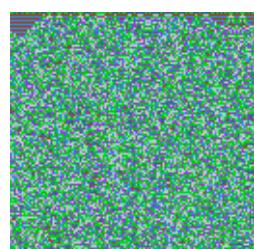
977 329 036 153 105 997 171 262 000 800

$$\rightarrow \{4 \rightarrow 4.68269 \times 10^{-6}, 3 \rightarrow 0.999995\},$$



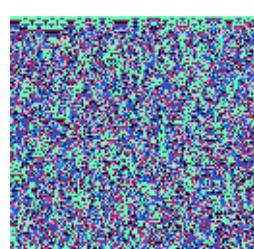
159 926 352 839 804 268 838 084 927 291 432

$$\rightarrow \{4 \rightarrow 7.76352 \times 10^{-8}, 3 \rightarrow 1.\},$$



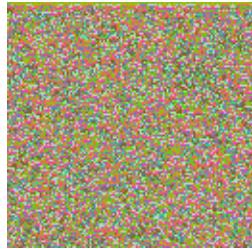
128 166 215 521 464 999 641 207 049 096 408

$$\rightarrow \{4 \rightarrow 1.69439 \times 10^{-8}, 3 \rightarrow 1.\},$$



114 847 198 255 004 709 483 758 163 190 071

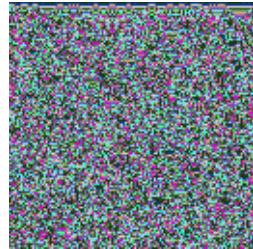
$$\rightarrow \{4 \rightarrow 5.17869 \times 10^{-10}, 3 \rightarrow 1.\},$$


 $\rightarrow \{4 \rightarrow 3.93143 \times 10^{-11}, 3 \rightarrow 1.\}\}$

8 133 953 189 708 915 561 841 617 496 797

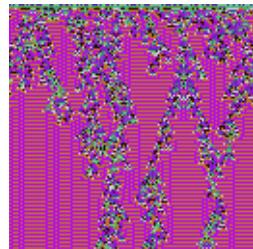
13-colour totalistic, range 1

```
In[2896]:= test4Data13kr1C18 = data13TC[8, 128, 128];
test4Data13kr1C18labeled = Thread[Labeled[
  Keys@test4Data13kr1C18, Values@test4Data13kr1C18, LabelStyle -> Small]];
Thread[test4Data13kr1C18labeled -> netECA18[Keys@test4Data13kr1C18,
  {"TopProbabilities", 2}]]
```

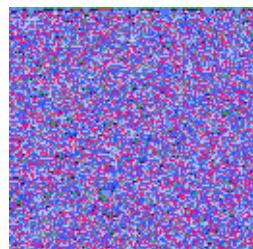

 $\rightarrow \{4 \rightarrow 2.05467 \times 10^{-7}, 3 \rightarrow 1.\},$

Out[2898]= {

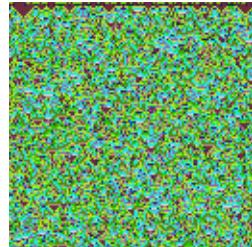
6 103 123 294 402 502 981 868 745 548 911 135 837 321


 $\rightarrow \{3 \rightarrow 9.30143 \times 10^{-14}, 4 \rightarrow 1.\},$

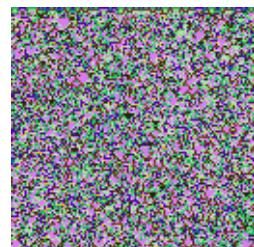
106 550 405 032 429 077 066 434 884 291 899 611 400 978


 $\rightarrow \{4 \rightarrow 0.00147584, 3 \rightarrow 0.998524\},$

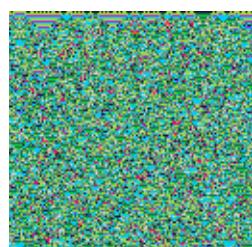
106 274 027 099 182 275 240 107 892 811 872 254 070 643


$$\rightarrow \{ 4 \rightarrow 8.8449 \times 10^{-14}, 3 \rightarrow 1. \},$$

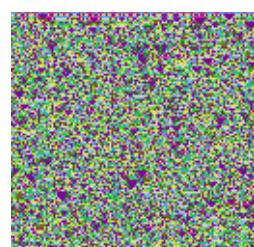
35 492 283 088 520 763 943 933 899 629 623 823 954 815


$$\rightarrow \{ 4 \rightarrow 3.98582 \times 10^{-9}, 3 \rightarrow 1. \},$$

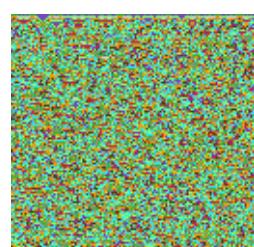
161 402 582 774 616 655 259 791 870 033 614 471 795 346


$$\rightarrow \{ 4 \rightarrow 0.000592673, 3 \rightarrow 0.999407 \},$$

18 263 666 525 899 018 024 371 019 044 712 509 167 550

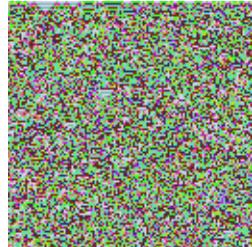

$$\rightarrow \{ 4 \rightarrow 5.78929 \times 10^{-9}, 3 \rightarrow 1. \},$$

102 080 152 456 686 970 978 802 756 652 577 590 060 017


$$\rightarrow \{ 4 \rightarrow 5.00531 \times 10^{-8}, 3 \rightarrow 1. \} \}$$

125 834 613 642 548 120 303 839 668 218 540 276 818 108

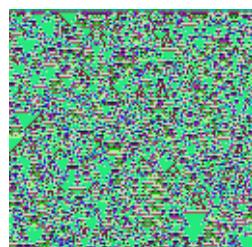
```
In[2953]:= test4Data13kr1C18 = data13TC[8, 128, 128];
test4Data13kr1C18labeled = Thread[Labeled[
  Keys@test4Data13kr1C18, Values@test4Data13kr1C18, LabelStyle -> Small]];
Thread[test4Data13kr1C18labeled -> netECA18[Keys@test4Data13kr1C18,
 {"TopProbabilities", 2}]]
```



Out[2955]= {

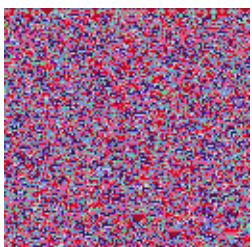
$$\rightarrow \{4 \rightarrow 8.11569 \times 10^{-8}, 3 \rightarrow 1.\},$$

112 616 590 556 927 094 888 532 603 688 885 006 558 155



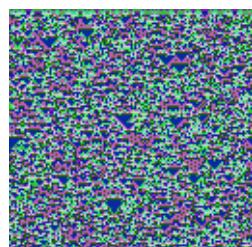
$$\rightarrow \{3 \rightarrow 1.38234 \times 10^{-9}, 4 \rightarrow 1.\},$$

147 547 043 318 248 481 936 532 693 136 837 831 363 300



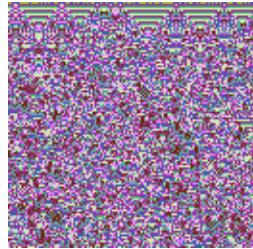
$$\rightarrow \{4 \rightarrow 0.069937, 3 \rightarrow 0.930063\},$$

86 815 343 224 285 776 525 466 345 126 350 418 077 070



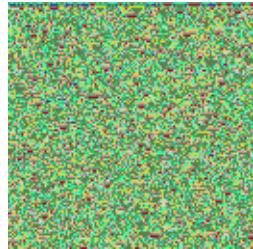
$$\rightarrow \{4 \rightarrow 1.26902 \times 10^{-18}, 3 \rightarrow 1.\},$$

122 189 265 005 308 917 685 591 615 135 219 800 414 317



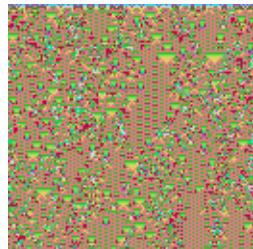
$$\rightarrow \{4 \rightarrow 5.57272 \times 10^{-10}, 3 \rightarrow 1.\},$$

84 302 145 275 231 150 442 171 607 803 948 203 930 785



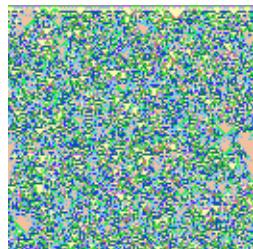
$$\rightarrow \{4 \rightarrow 6.03381 \times 10^{-8}, 3 \rightarrow 1.\},$$

52 870 058 906 905 244 649 989 062 077 220 650 151 031



$$\rightarrow \{3 \rightarrow 0.24612, 4 \rightarrow 0.75388\},$$

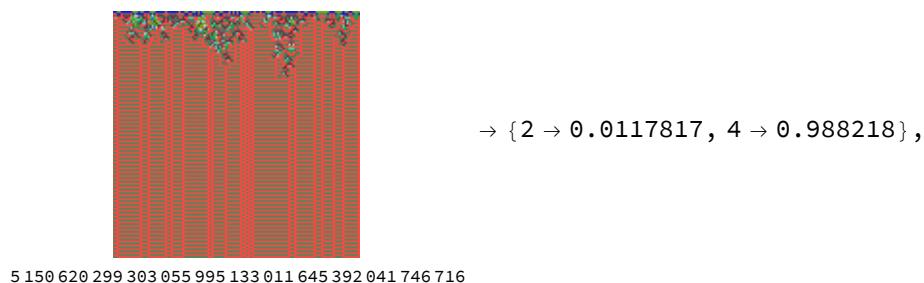
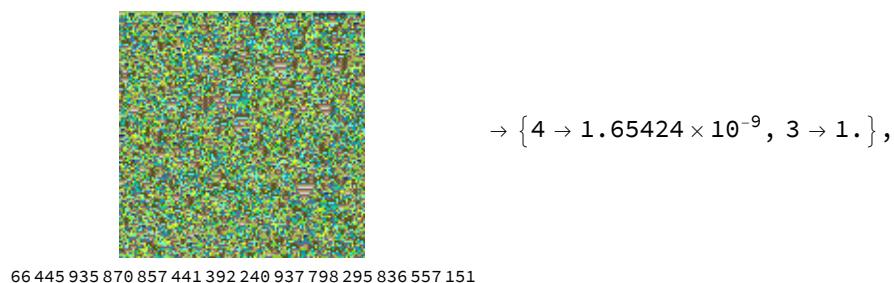
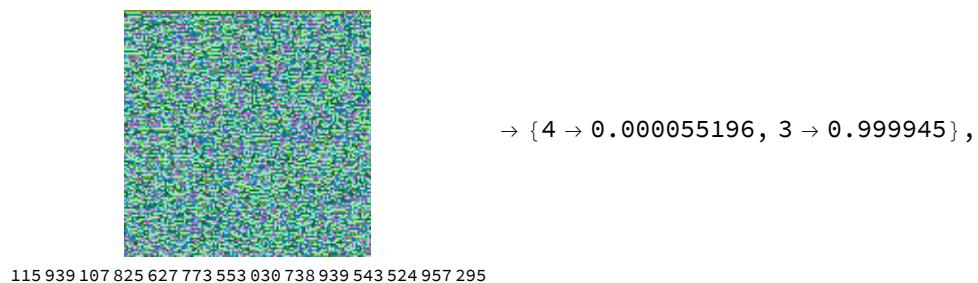
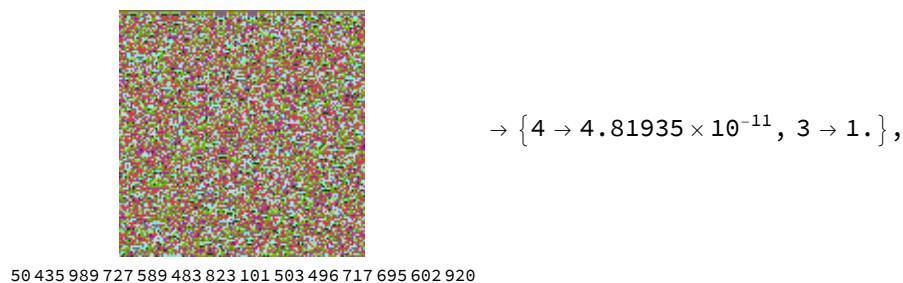
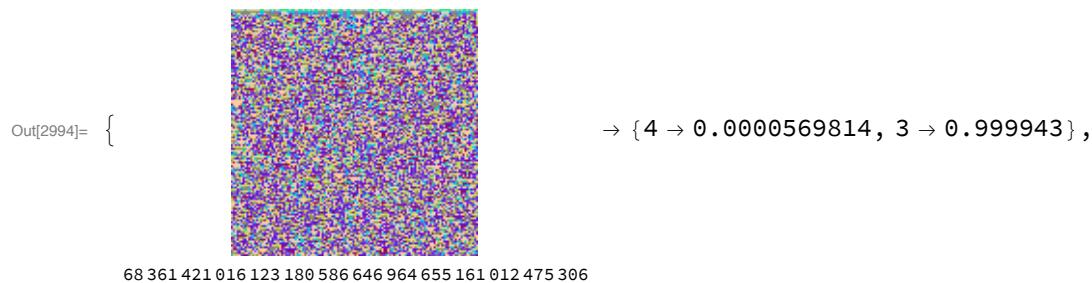
37 887 941 994 877 567 121 174 282 109 822 487 171 610

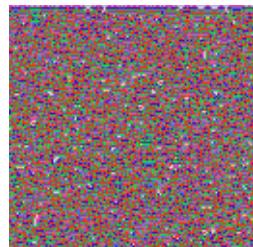


$$\rightarrow \{4 \rightarrow 2.41923 \times 10^{-17}, 3 \rightarrow 1.\}\}$$

42 447 326 519 091 792 640 281 557 096 782 893 398 955

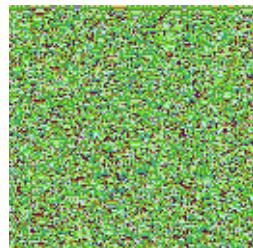
```
In[2992]:= test4Data13kr1C18 = data13TC[8, 128, 128];
test4Data13kr1C18labeled = Thread[Labeled[
  Keys@test4Data13kr1C18, Values@test4Data13kr1C18, LabelStyle -> Small]];
Thread[test4Data13kr1C18labeled -> netECA18[Keys@test4Data13kr1C18,
 {"TopProbabilities", 2}]]
```





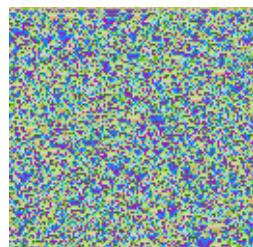
$$\rightarrow \{ 4 \rightarrow 7.54567 \times 10^{-11}, 3 \rightarrow 1. \},$$

111 087 232 193 664 150 150 947 934 002 448 211 357 606



$$\rightarrow \{ 4 \rightarrow 3.72681 \times 10^{-8}, 3 \rightarrow 1. \},$$

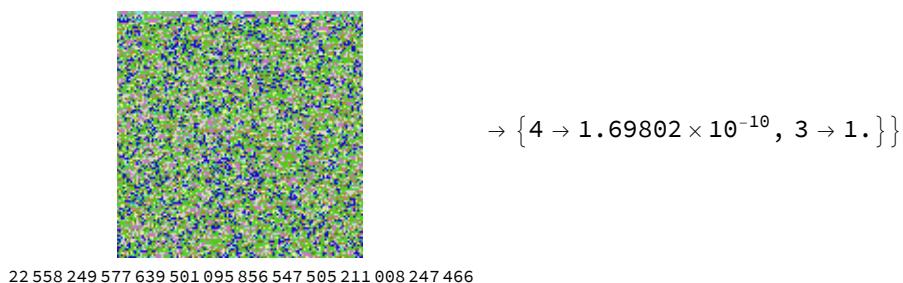
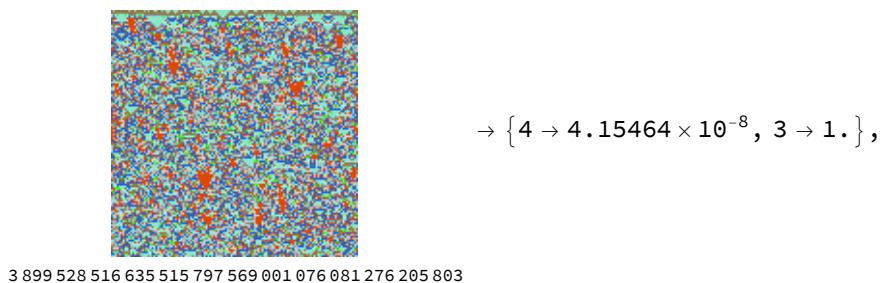
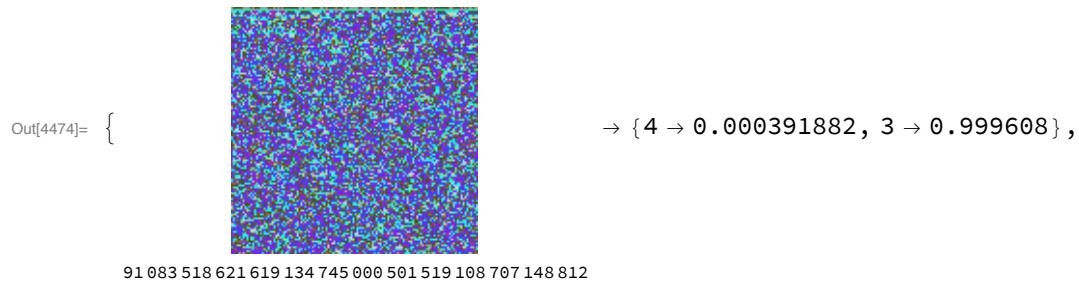
155 484 101 899 368 243 086 664 036 992 364 523 712 035



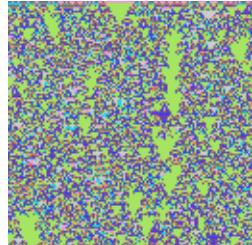
$$\rightarrow \{ 4 \rightarrow 5.03395 \times 10^{-7}, 3 \rightarrow 1. \} \}$$

134 247 196 104 036 999 031 892 914 357 269 398 081 674

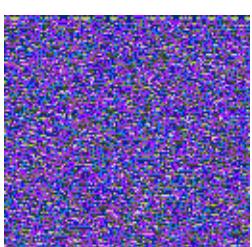
```
In[4472]:= test4Data13kr1C18 = data13TC[4, 128, 128];
test4Data13kr1C18labeled = Thread[Labeled[
  Keys@test4Data13kr1C18, Values@test4Data13kr1C18, LabelStyle -> Small]];
Thread[test4Data13kr1C18labeled -> netECA18[Keys@test4Data13kr1C18,
 {"TopProbabilities", 2}]]
```



```
In[4704]:= test4Data13kr1C18 = data13TC[4, 128, 128];
test4Data13kr1C18labeled = Thread[Labeled[
  Keys@test4Data13kr1C18, Values@test4Data13kr1C18, LabelStyle -> Small]];
Thread[test4Data13kr1C18labeled -> netECA18[Keys@test4Data13kr1C18,
 {"TopProbabilities", 2}]]
```

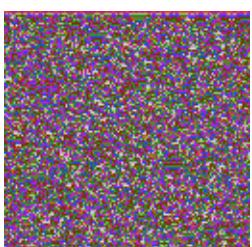


Out[4706]= {
 $\rightarrow \{3 \rightarrow 0.00079505, 4 \rightarrow 0.999205\},$
 109 741 664 168 905 450 804 838 041 017 590 794 944 169}



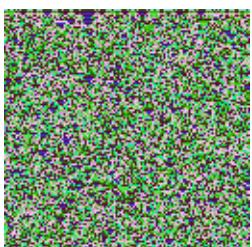
$\rightarrow \{4 \rightarrow 5.49097 \times 10^{-6}, 3 \rightarrow 0.999995\},$

93 114 571 692 612 342 115 900 947 486 824 760 344 049



$\rightarrow \{4 \rightarrow 0.0000256157, 3 \rightarrow 0.999974\},$

27 423 183 048 713 203 556 487 234 188 802 241 238 092

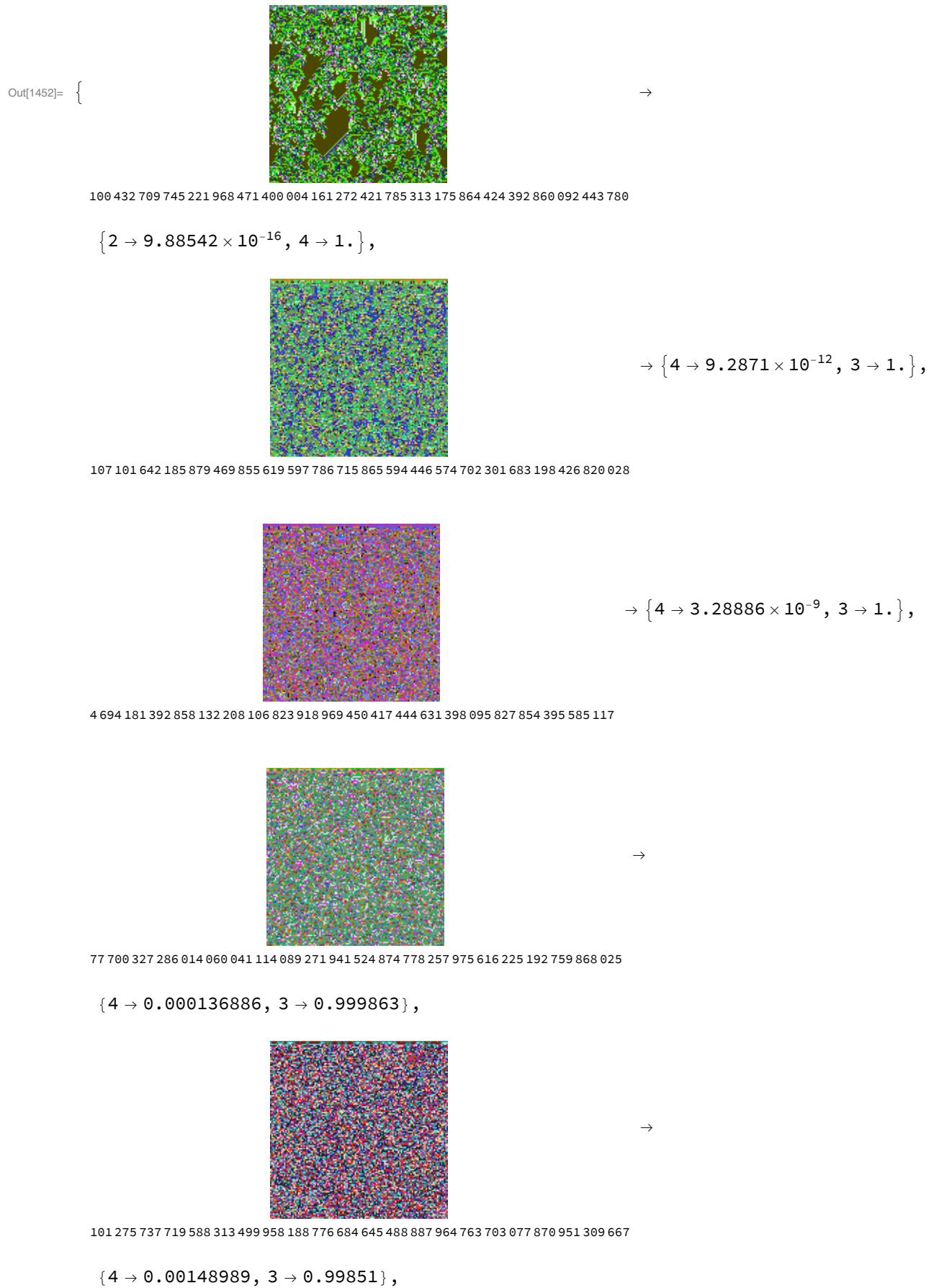


$\rightarrow \{4 \rightarrow 9.98635 \times 10^{-7}, 3 \rightarrow 0.999999\}\}$

55 098 497 555 559 121 721 470 626 167 518 826 423 849

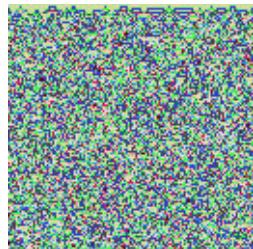
18-colour totalistic, range 1

```
In[4705]:= test4Data18kr1C18 = data18TC[8, 128, 128];
test4Data18kr1C18labeled = Thread[Labeled[
  Keys@test4Data18kr1C18, Values@test4Data18kr1C18, LabelStyle -> Small]];
Thread[test4Data18kr1C18labeled -> netECA18[Keys@test4Data18kr1C18,
 {"TopProbabilities", 2}]]
```




 $\rightarrow \{4 \rightarrow 4.94333 \times 10^{-12}, 3 \rightarrow 1.\},$

31 330 139 254 828 030 520 812 274 076 452 349 678 165 064 863 828 483 555 288 280 047


 $\rightarrow \{3 \rightarrow 0.28896, 4 \rightarrow 0.71104\},$

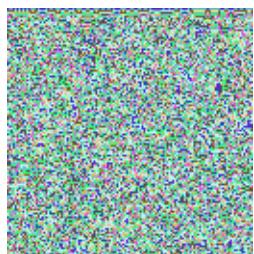
160 047 496 270 492 329 204 041 848 237 376 187 065 045 724 082 331 147 631 919 936 795


 \rightarrow

131 248 368 813 783 732 937 063 439 793 510 226 771 975 010 899 085 872 633 783 660 532

$\{4 \rightarrow 0.0000118765, 3 \rightarrow 0.999988\}\}$

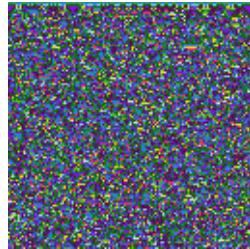
```
In[1459]:= test4Data18kr1C18 = data18TC[8, 128, 128];
test4Data18kr1C18labeled = Thread[Labeled[
  Keys@test4Data18kr1C18, Values@test4Data18kr1C18, LabelStyle -> Small]];
Thread[test4Data18kr1C18labeled -> netECA18[Keys@test4Data18kr1C18,
 {"TopProbabilities", 2}]]
```


 \rightarrow

Out[1461]= {

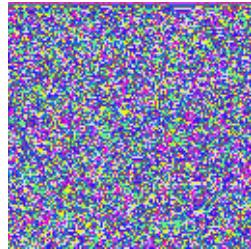
84 407 891 860 608 186 800 342 925 777 103 111 012 730 709 614 871 448 322 966 842 743

$\{4 \rightarrow 0.000107331, 3 \rightarrow 0.999893\},$

 \rightarrow

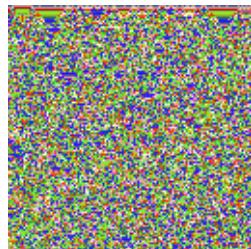
161 424 174 456 430 728 167 518 922 554 123 708 832 493 894 459 273 117 300 803 992 860

$$\{4 \rightarrow 1.09406 \times 10^{-10}, 3 \rightarrow 1.\},$$

 \rightarrow

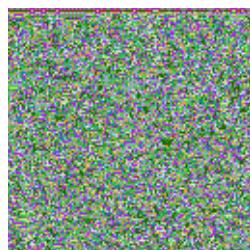
78 032 217 344 344 330 867 403 680 915 204 373 154 822 648 823 501 092 588 035 610 835

$$\{4 \rightarrow 4.26104 \times 10^{-6}, 3 \rightarrow 0.999996\},$$

 \rightarrow

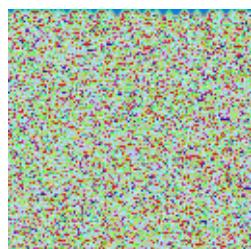
17 514 930 310 957 860 289 760 217 211 982 312 893 914 895 733 884 156 147 675 071 979

$$\{4 \rightarrow 3.02896 \times 10^{-6}, 3 \rightarrow 0.999997\},$$

 \rightarrow

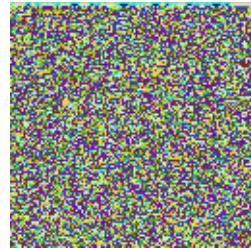
126 337 368 684 499 459 452 874 800 008 665 847 585 515 559 961 310 661 358 461 150 478 987

$$\{4 \rightarrow 6.83088 \times 10^{-11}, 3 \rightarrow 1.\},$$



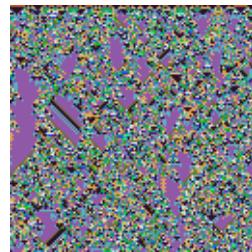
$$\rightarrow \{4 \rightarrow 4.53993 \times 10^{-9}, 3 \rightarrow 1.\},$$

40 213 870 254 046 402 060 993 100 884 679 132 055 568 662 380 628 182 270 851 703 964



$$\rightarrow \{4 \rightarrow 1.55591 \times 10^{-10}, 3 \rightarrow 1.\},$$

51 884 643 645 127 688 338 260 865 508 261 671 962 402 238 325 831 463 126 617 291 758

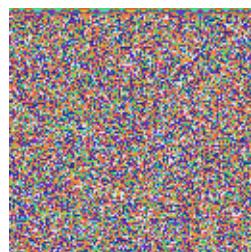


\rightarrow

105 981 239 442 692 171 040 307 215 500 165 460 050 735 782 946 669 540 434 861 001 557

$$\{2 \rightarrow 1.37062 \times 10^{-16}, 4 \rightarrow 1.\}\}$$

```
In[1516]:= test4Data18kr1C18 = data18TC[8, 128, 128];
test4Data18kr1C18labeled = Thread[Labeled[
  Keys@test4Data18kr1C18, Values@test4Data18kr1C18, LabelStyle -> Small]];
Thread[test4Data18kr1C18labeled -> netECA18[Keys@test4Data18kr1C18,
 {"TopProbabilities", 2}]]
```

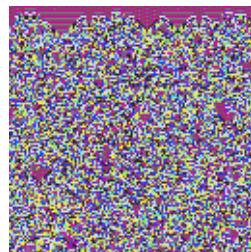


\rightarrow

Out[1518]= {

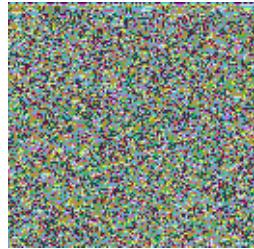
67 097 332 073 690 877 096 462 393 318 551 121 105 627 611 874 073 821 346 080 316 259

$$\{4 \rightarrow 5.10358 \times 10^{-11}, 3 \rightarrow 1.\},$$

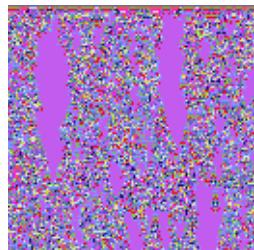


$$\rightarrow \{4 \rightarrow 6.51776 \times 10^{-10}, 3 \rightarrow 1.\},$$

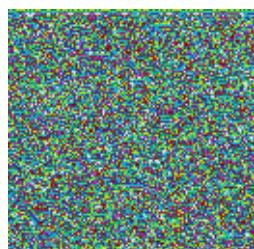
469 341 525 975 528 605 442 938 764 400 684 210 544 509 817 697 780 635 610 240 385


 $\rightarrow \{ 4 \rightarrow 5.69048 \times 10^{-9}, 3 \rightarrow 1. \},$

92 797 071 861 825 599 650 393 018 230 465 068 427 103 727 472 152 026 271 875 491 041


 $\rightarrow \{ 2 \rightarrow 4.64192 \times 10^{-12}, 4 \rightarrow 1. \},$

48 707 525 714 524 878 716 517 127 579 370 682 054 079 882 568 456 080 106 934 725 549

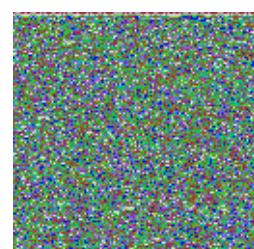

 \rightarrow

44 770 759 776 338 013 160 561 529 662 542 939 808 723 595 235 004 541 281 157 081 136

 $\{ 4 \rightarrow 9.2328 \times 10^{-7}, 3 \rightarrow 0.999999 \},$

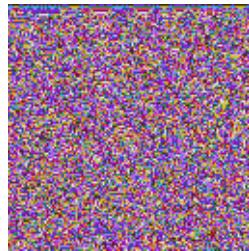
 $\rightarrow \{ 4 \rightarrow 1.19647 \times 10^{-8}, 3 \rightarrow 1. \},$

860 018 757 961 576 225 864 410 760 233 199 100 592 057 684 375 923 534 430 897 683


 \rightarrow

164 751 184 453 635 689 907 701 761 887 389 137 319 437 941 824 750 165 777 001 238 660

 $\{ 4 \rightarrow 0.000073185, 3 \rightarrow 0.999927 \},$



→

30 824 548 023 101 519 695 632 494 294 594 245 489 101 989 183 582 883 081 905 253 160

$\{4 \rightarrow 0.00834654, 3 \rightarrow 0.991653\}$

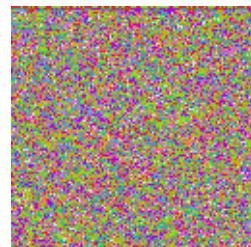
18-colour totalistic, range 2

```
In[1828]:= test4Data18kr2C18 = data18TC2[4, 128, 128];
test4Data18kr2C18labeled = Thread[Labeled[
  Keys@test4Data18kr2C18, Values@test4Data18kr2C18, LabelStyle -> Small]];
Thread[test4Data18kr2C18labeled -> netECA18[Keys@test4Data18kr2C18,
  {"TopProbabilities", 2}]]
```

Out[1830]= {

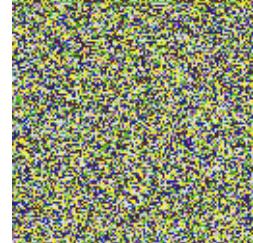


769 577 573 466 025 522 597 791 333 566 696 507 840 149 861 268 716 899 301 418 586 396 291 252 894 704 888 529 248 410 985 300 217 241
 674 424



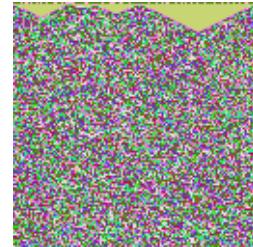
411 003 821 136 139 319 136 688 670 995 759 171 543 568 050 223 522 931 643 480 855 395 606 766 494 725 714 384 977 081 013 686 517 667
 791 497

```
In[1999]:= test4Data18kr2C18 = data18TC2[4, 128, 128];
test4Data18kr2C18labeled = Thread[Labeled[
  Keys@test4Data18kr2C18, Values@test4Data18kr2C18, LabelStyle -> Small]];
Thread[test4Data18kr2C18labeled -> netECA18[Keys@test4Data18kr2C18,
 {"TopProbabilities", 2}]]
```



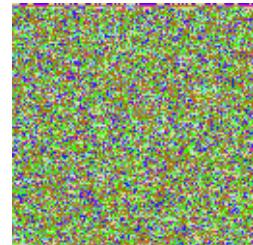
Out[2001]= {

```
121 579 332 772 923 774 133 355 884 758 752 147 770 364 295 623 376 685 048 064 022 803 272 028 982 310 029 722 379 946 341 198 504 205 ...
012 706
```



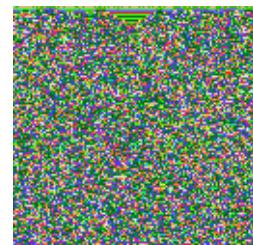
```
624 598 404 996 637 016 683 114 401 813 780 473 705 630 660 202 981 453 755 290 146 978 865 400 232 969 734 341 197 799 730 464 576 892 ...
503 296
```

```
In[2314]:= test4Data18kr2C18 = data18TC2[4, 128, 128];
test4Data18kr2C18labeled = Thread[Labeled[
  Keys@test4Data18kr2C18, Values@test4Data18kr2C18, LabelStyle -> Small]];
Thread[test4Data18kr2C18labeled -> netECA18[Keys@test4Data18kr2C18,
 {"TopProbabilities", 2}]]
```



Out[2316]= {

```
881 874 999 022 756 543 726 036 478 964 237 477 431 822 136 010 021 207 702 219 350 371 246 067 945 230 511 817 990 209 765 276 238 563 ...
402 316
```



```
828 938 597 795 819 524 814 601 171 753 212 770 000 242 306 577 066 618 518 677 428 232 970 053 311 565 671 372 277 988 845 018 666 154 ...
575 722
```

