Pixel Picture

Suggested Grade Level: 6–8

Summary

- Students will transmit and reproduce an image from Mars using numbers and pixels (picture elements) in order to model the way in which a spacecraft transmits planetary images to Earth.
- With the materials provided, students or teams will create lines (rows) and columns of numbers from an image and transmit them to other students/teams so that they can recreate the image from the numbers.

Standards

- NM State Science Content Standards: Strand I, Scientific Thinking and Practice National Science Standards: Standard E, Technological Design

Background Information

If you carefully look at a newspaper photograph or an image on a computer screen, you will see that it is composed of small squares of different shades of gray. As you zoom in to the photograph or image, you can see these individual squares. This is exactly the way planetary images are produced. Images are transmitted by spacecraft as a stream of numbers. Each number relates to a shade of gray (gray¬tone) within a small square area called a pixel (picture element). If a picture is divided into only a few pixels, only the broad outline of a feature would be visible and no details would be visible in the picture. In this case, each pixel would cover a large area of the region being imaged, and this is called a low-resolution image. If the same picture is divided into many pixels, each pixel would cover a much smaller area of the region being imaged and would be able to show many more details. This image would be considered high-resolution.

Mathematically, the real area included within a pixel can be expressed by the number of inches or meters (or feet, miles, or kilometers) per pixel. You can demonstrate this to your students by drawing a quick sketch of a tree on the chalkboard. Draw lines over the tree to form a large grid with six blocks, each block covering an area of several feet or meters depending on the size of the tree. If you colored each block for the dominant color within the block, blue for sky, green for leaves, brown for the bark, you would get a very blocky-looking depiction of a tree. The more grid lines drawn over the tree, the smaller and more numerous the blocks, the more detailed the image would become.

Remember that each pixel is given a single number that defines its dominant color or gray-tone; that means that features that are so small that they fit within a pixel cannot be seen on the image. In fact, it takes at least three pixels to really see (or resolve) a feature on the image. For example, if the resolution of your image is such that each pixel represents a distance of 75 meters or 246 ft on the surface (which is considered high-resolution for planetary orbiter images), then you would be able to see only features that are at least 225 meters or 740 ft across (about equal to or greater than the size of a football field) on the surface of the planet.

Most planetary images are sent in black and white and then "colorized" by computer based on various types of color calibration techniques, similar to the technique used to "colorize" old movies that were originally filmed in black and white. In addition to the number of pixels, detail can also be increased by increasing the number of gray tones between black and white. Most spacecraft images have at least 256 shades of gray, each of which is assigned a numerical value. The image in this activity only has eight shades from white through gray tones to black and numbered 0 through 7.

Materials

- One classroom or large room, or two adjacent rooms
- Tables of sufficient size for students/teams and placed separately from the other students/teams
- Glue sticks, paper, and pencils
- A black and white orbiter image of a small impact crater on Mars, included in this activity
- A close-up image showing the individual pixels (picture elements) used to create this crater image, included in this activity
- The close-up image above with a grid drawn on it, included in this activity
- The grid by itself, included in this activity
- The grid with numbers on it, included in this activity
- The gray-tone "tiles" of eight shades of white through gray tones to black, included in this activity

Preparation

1. Print copies of all images and grids listed above.

2. Print several copies of the gray-tone tiles sheet and cut the tiles up into small squares. Divide the tiles by shade or gray-tone (number) into boxes labeled # 0 through #7 so that students can select the appropriate numbered tiles. A set of boxes with tiles should be prepared for each encoding and decoding team.

3. Photocopy the grid without numbers so that there are at least three copies for each group.

4. Divide the class into two to four groups and set up separate work areas for each group.

Introduction for Students

How are images sent to Earth from planetary spacecraft when the spacecraft never returns to Earth? Images are returned to Earth as a stream of numbers. How is this done? If I draw a simple picture of a tree on the board, how would you send this picture to a friend using only numbers? How do you turn a picture into numbers? How many numbers would you need? How would you encode this picture? What would your friend have to do in order to decode the numbers you sent? You are going to experiment with encoding and decoding an actual image from Mars.

Procedure

1. Divide students into at least two teams, one to encode the image and one to decode the image. If you wish, you can run two sets of two teams simultaneously, with each pair of teams doing the complete image or working on one-half of the image that will then be put together at the end of the activity.

2. Give the encoding group(s) the orbiter image of the crater, the close-up image, the close-up image with grid drawn on it (or the students can draw the grid themselves), three copies of the grid without numbers, and the boxes of tiles. If you wish, you can cut all of these in half and give one-half of all of the images and materials to two encoding groups.

3. The encoding group should begin to correlate the gray-tones with the correct numbers and write a number in each box of one copy of the grid. The encoding group should decide whether they will work across the grid in lines or columns. The group can write numbers by comparing tiles from the numbered boxes or by actually selecting tiles from the boxes and gluing them to either the image or to one of the copies of the grids. They should begin to write the appropriate numbers across or down a second copy of the grid.

4. As the encoding proceeds, single or double lines or columns (labeled as Line #1, Line #2 or Column #1, Column #2, etc.) can be "sent" as a stream of numbers on a piece of paper.

5. The decoding group(s) should be some distance from the encoding group and should initially be given two copies of the numberless grid. They should also have numbered boxes of tiles on their table.

6. The decoding group(s) should receive the line or column of numbers periodically from the decoding group. First they should write the numbers down on the appropriate pixels on one of their grids, then they should select the appropriate tiles and glue them to the correct pixels on their second grid.

7. When the decoding is complete and an image has been produced by gluing a series of pixels to a grid, then all of the students should gather and the decoding teams should be shown the original close-up image and the original orbiter image of the impact crater that they have recreated.

Process/Closure

What are the differences between this activity and the creation of a real planetary image from a spacecraft? Is this a good way to transmit images? What are the problems with this technique? What are the advantages? How could the impact crater image in this activity be produced with more detail? How could a color image be transmitted using this technique?

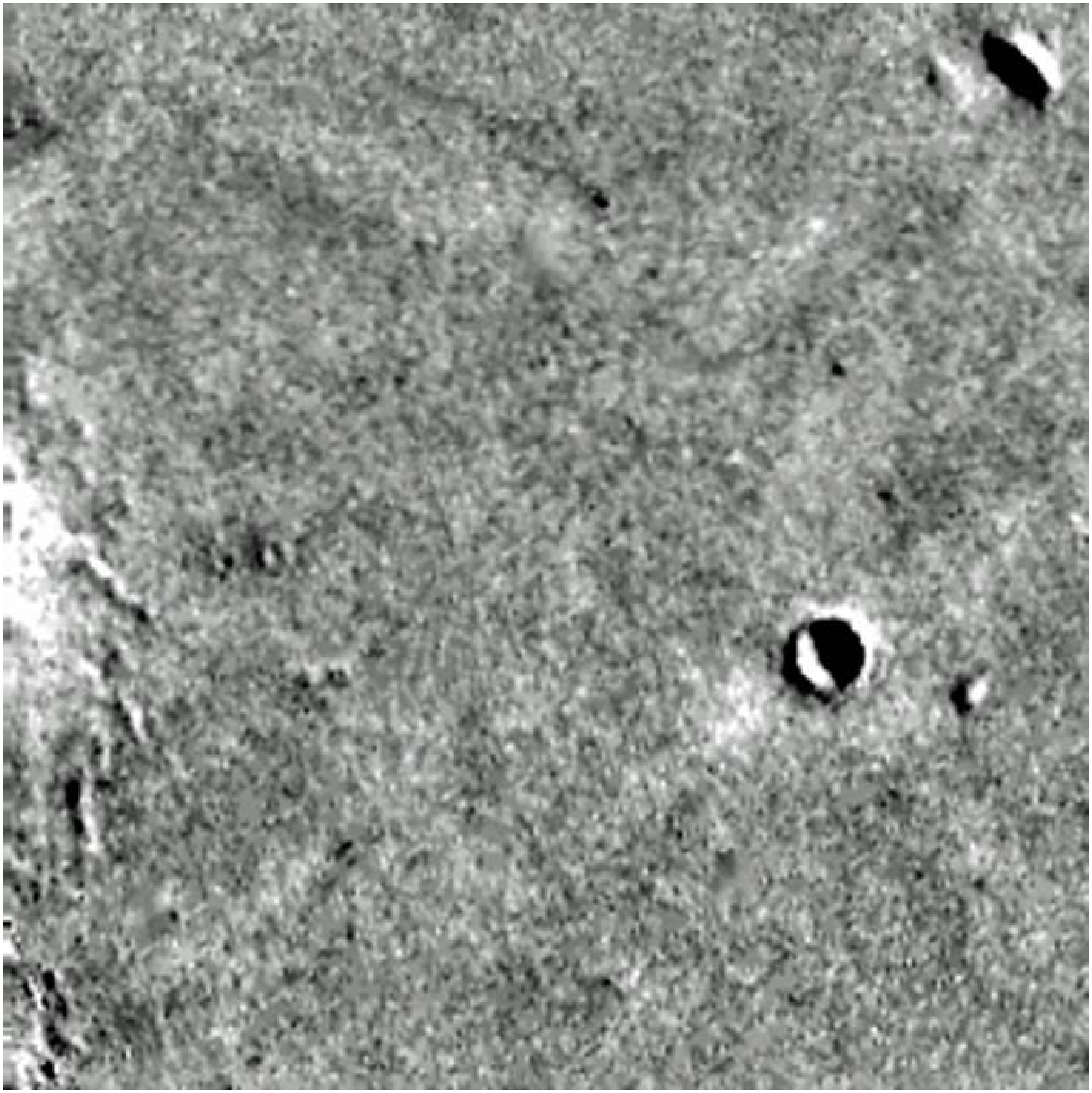
Extension/Enrichment

If the impact crater in this activity has a diameter of 20 km (about 12 miles), have students calculate how much of the surface each pixel in this image represents. If they had a similar resolution satellite image of their city or town, what size features would be visible? Their house? school? sports arena? nearby mountains, river, or reservoir?

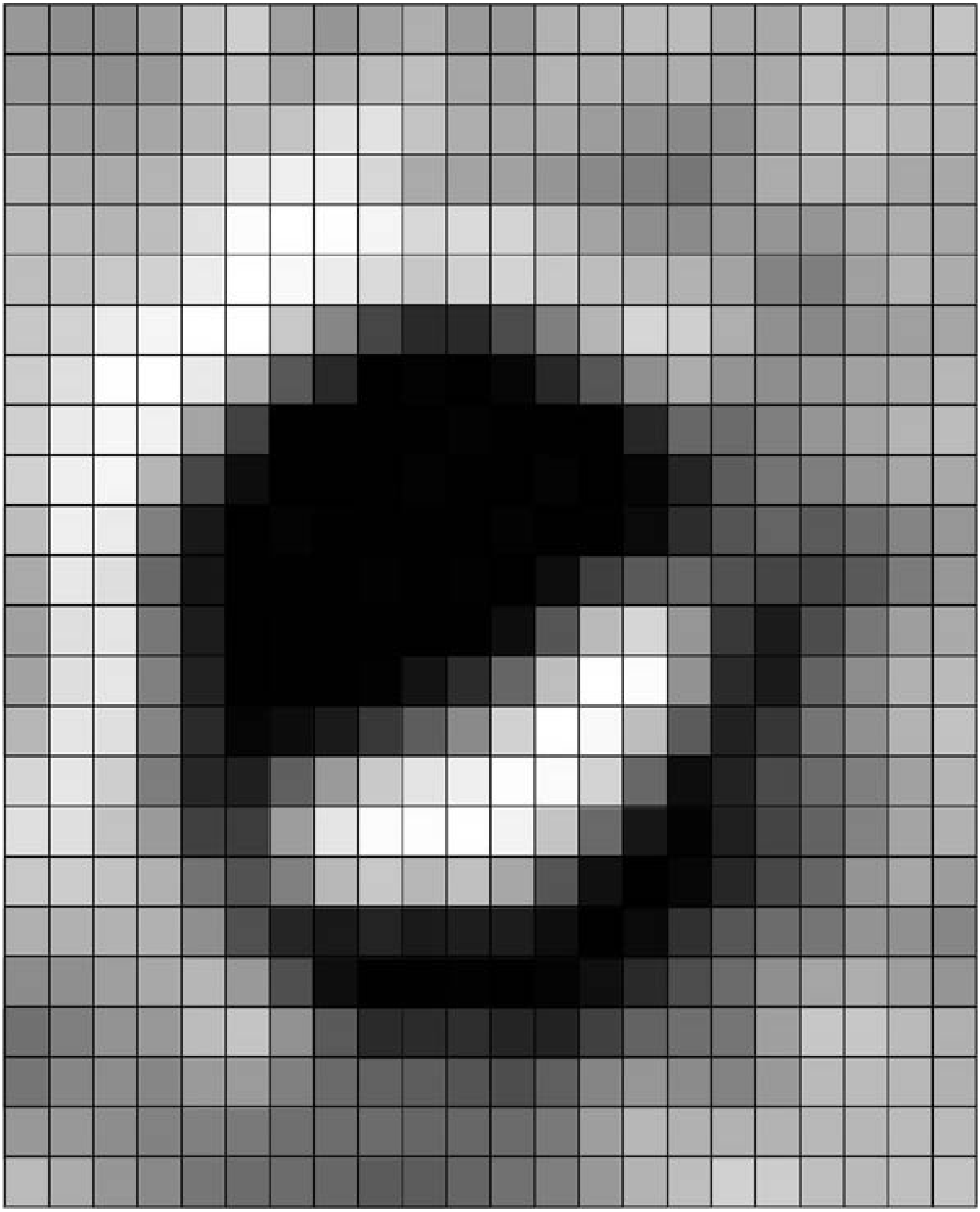
Other simple pictures can be encoded and decoded. Have students bring in images to grid and number and reproduce. Or a student team can create a new picture by coloring in squares of a grid, assigning numbers to the colors they have used, and transmitting those numbers to another team.

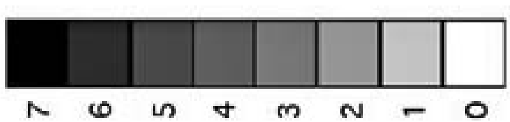
Credits

This activity was created by Jayne Aubele for the NASA Rhode Island Space Grant Program and adapted by her for this Guide.



Orbiter Image of Impact Crater and Surrounding Area on Mars




7
6
5
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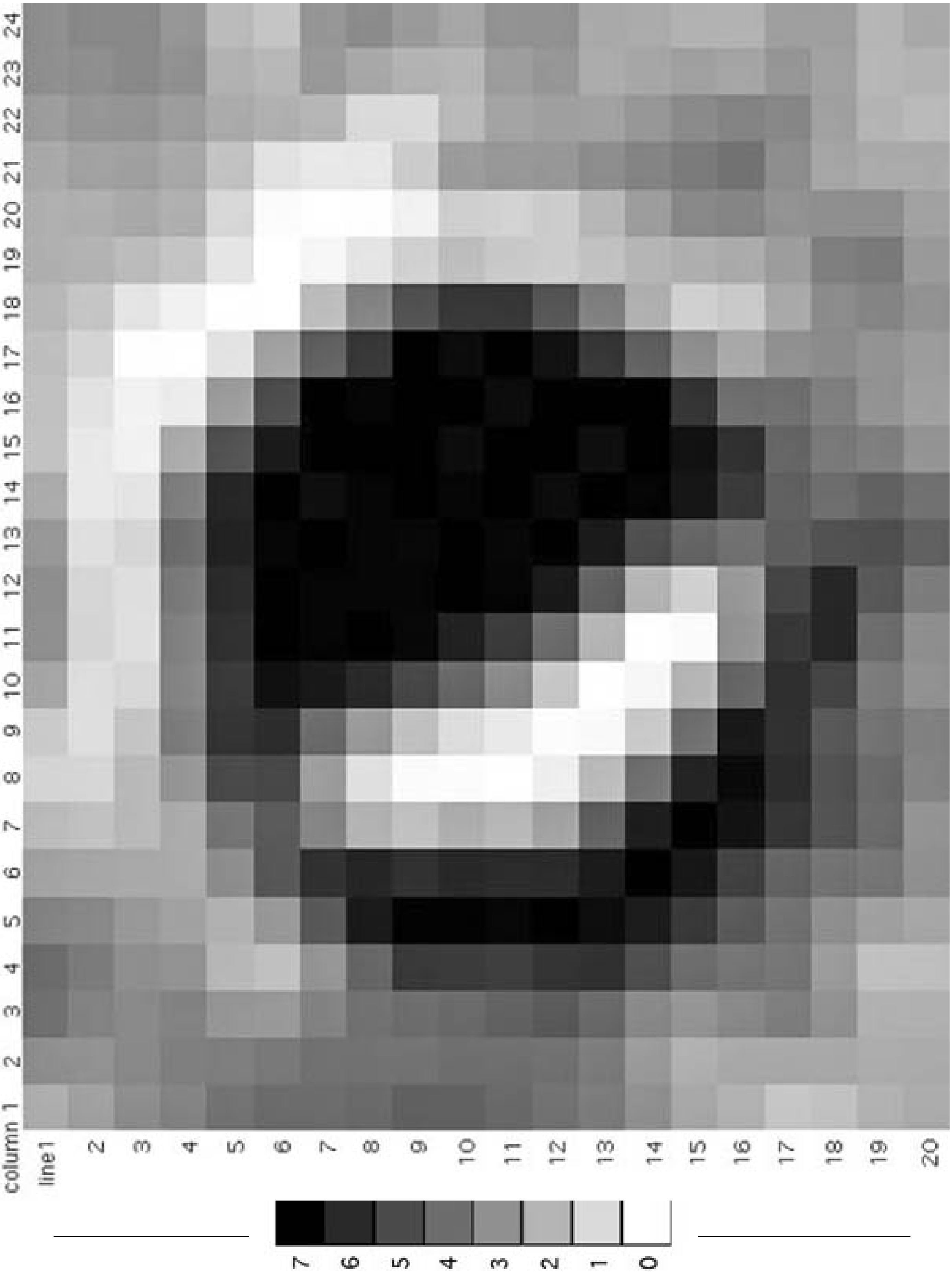
2
1
0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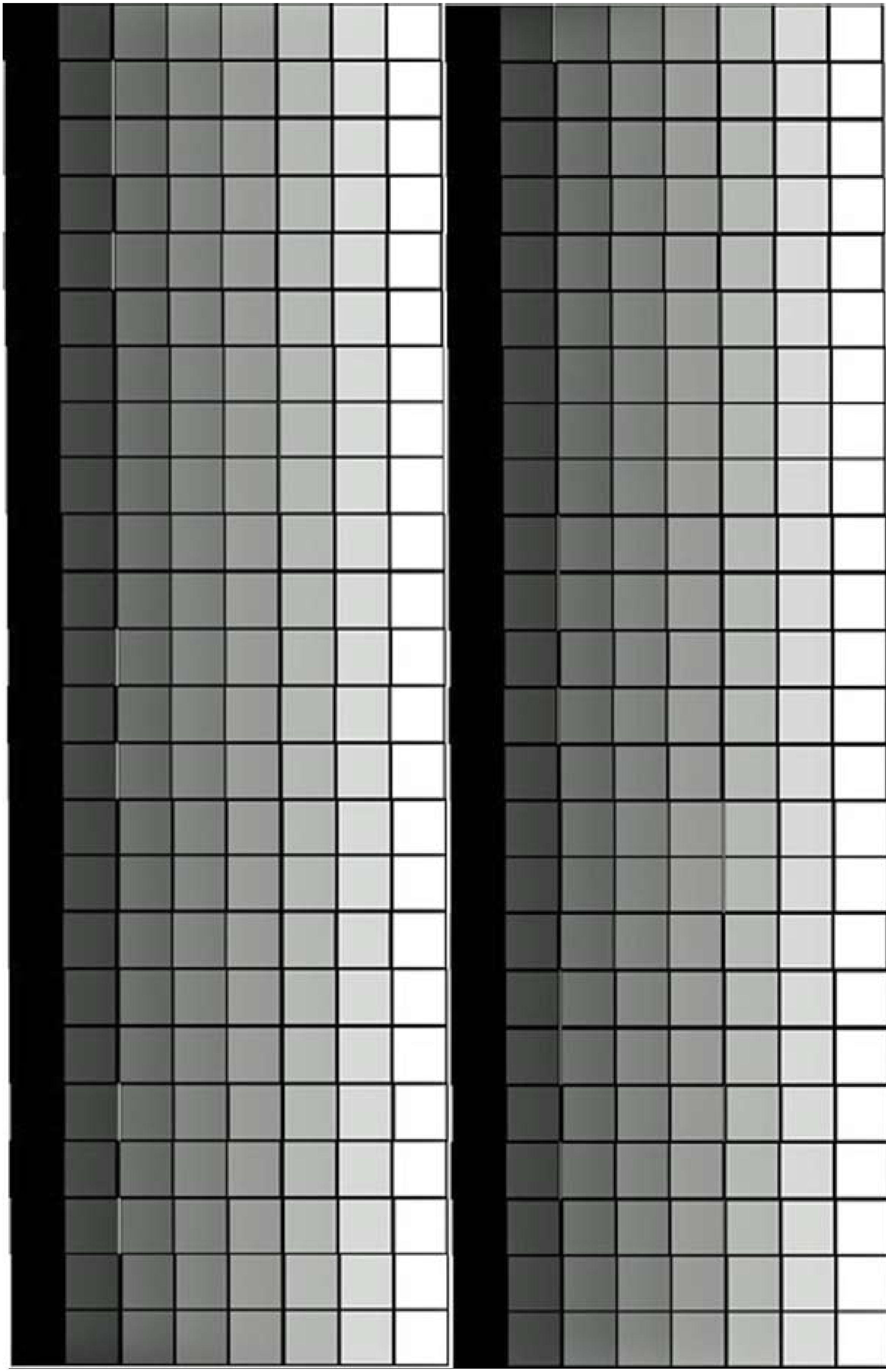
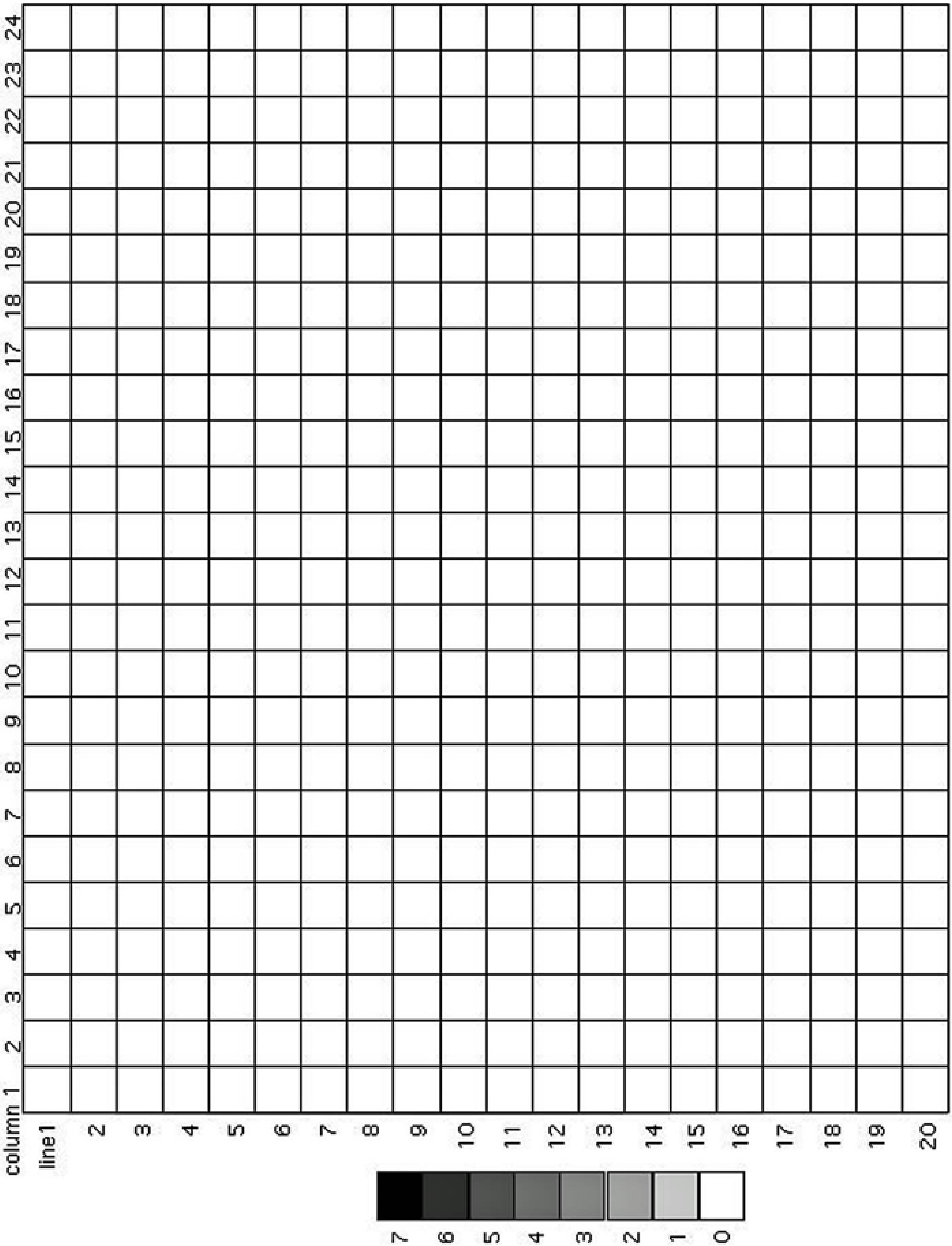
line1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
7 6 5 4 3 2 1 0



Gray-tone "Tiles"

Pixel Grid


column 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
line 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
7 6 5 4 3 2 1 0

column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
line1	2	2	3	3	2	1	1	1	2	2	2	2	2	1	1	1	2	2	2	2	2	2	2	2
2	2	2	3	3	2	2	1	1	0	1	1	1	0	0	0	0	1	1	2	2	2	2	3	3
3	2	3	3	3	2	2	2	1	1	0	0	1	1	0	0	0	0	1	1	2	2	2	3	3
4	2	3	3	3	2	2	2	3	4	3	3	3	4	3	2	1	0	1	2	2	2	3	2	2
5	3	3	2	1	1	2	3	5	7	5	5	6	7	7	3	2	1	0	1	1	2	2	2	2
6	3	3	2	1	2	4	4	5	6	7	7	7	7	7	7	5	2	0	0	0	1	2	2	2
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10	4	3	3	5	7	6	2	1	1	4	7	7	7	7	7	7	7	5	1	1	2	2	2	2
11	3	3	4	5	7	6	2	0	1	3	5	7	7	7	7	7	7	5	1	1	2	2	2	2
12	3	3	4	5	7	6	2	1	0	1	4	7	7	7	7	7	7	4	1	1	2	2	2	2
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14	2	3	3	4	7	7	7	5	2	1	0	2	4	7	7	7	4	2	2	2	2	2	2	2
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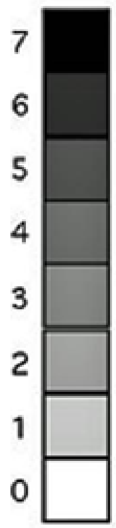

Pixel Grid with Gray-tone Numbers