Digital Image Files

A learner-centered inquiry

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Digital Image Files

Inquiry Lesson Plan

Audience: Community College Engineering students
Number of students: 24-26 students
Time: two class periods, each of 2 hours forty-five minutes
Required roles: 4 facilitators *minimum*; 5 are better to allow an extra 'floater' where needed

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I Overview

A OBJECTIVES

1 Content Goals

Students should know that digital pictures are made of numbers and characters.
Students should understand pixels and arrays.
Students should understand grayscale and bit depth.
Students should understand image file formats and header information.
Students should have facility with basic image manipulation and processing.
Students should understand the difference between continuous and discrete.
Students should understand tradeoffs, such as spatial scale and color scale.

2 Process Goals

Students should be able to define a problem.
Students should be able to propose a solution.
Students should communicate information in writing.
Students should be able to evaluate tradeoffs.
Students should be able to solve a problem with constraints.
Students should carry out steps of the engineering process.

3 Attitudinal Goals

Students should feel part of an engineering team in solving a problem.
Students should enjoy being creative in designing their own image file format.
Students should feel comfortable working on an engineering problem.

4 CfAO Program Goals

Students should draw on prior knowledge.
Students should be able to observe and communicate.
Students should gain preparation for jobs/careers.
Students should make predictions about how an image will look after the numbers in the file are manipulated in certain specified ways.

B SCHEDULE (9:00am-11:45am) Two days, each 2 hr 45 min.

1 Day 1

- Time for class to start and introductions (9:00-9:05) 5 min. (Mark)
- Introduction to digital images and Design Task(9:10-9:20) 15 min. (Katie)
- Thinking Tools / Starter activities (9:20-10:00) 40 min (All)
- Break (10:00-10:15) 15 min.
- Post-starter synthesis; Intro to focused investigation (10:15-10:30) 15 min. (Chris)
- Focused Investigation: Image encoding (10:30-11:35) 65 min. (All facilitators)
- Day 1 closing and homework assignment (11:35-11:45) 10 min. (Ian)

<u>Homework:</u> *Image file writeup and self-reflection paper.*

2 Day 2

- Day 1 refresher/Introduction to day 2 (9:00-9:10) 10 min. (Katie)
- Investigation: Image decoding (9:10-9:50) 40 min. (All)
- Prepare for Sharing (9:50-10:10) 20 min. (All)
- Break (10:10-10:25) 15 min.
- Jigsaw Sharing (10:25-10:55) 30 min. (All facilitators)
- Synthesis and Closing (10:55-11:20) 25 min. (Chris)
- Feedback and Post-activity homework assignment (11:20-11:30) 10 min. (Chris)

<u>Homework:</u> *Lab writeup.*

II Full activity description

1 General Materials:

- Nametags for students and guest teachers.
    - Name written in one of three colors (for breakout discussion groups on the 2nd day)
    - A number (1, 2, 3, or 4) for each of the four starter groups
    - A letter (A, H, K, L, M, N, P, U, W) for each of the investigation groups

2 Introduction to digital images and Inquiry

Time: 9:10-9:25—20 *min.*
Facilitator: Katie
Time: 15 min.
Materials:

- "Engineering task" problem statements

Strategy: (See powerpoint slides "opener_day1.ppt").

1. Introduce facilitators and team members; ~ 1 min per member
2. Introduce digital images:
    1. "Today we will be exploring digital images, which are a way to transmit pictures."
    2. "When/why might someone want to transmit a picture?"
        i. *Photo of people to send to far-away relatives*
        ii. *Save photo for later, to remember what one looked like years ago*
        iii. *Memories of old times*
    3. "What kinds of information do and don't pictures contain?"
        i. *Do contain things seen*
        ii. *Do not contain things heard, smelled, tasted, or touched*
    4. "How is a digital camera different from an old-fashioned film camera?"
        i. *The way it stores the picture: Film camera—photo-sensitive chemicals on specialized paper. Digital camera—image file (jpeg) with numbers.*
3. Introduce the inquiry activity using modified CfAO PDP script for engineering.
    1. Today and Thursday we are going to do an inquiry about digital image files.
    2. This might be different from other classes but inquiry can be a lot of fun and very rewarding if you stay engaged in the activity.
    3. We will first do a series of "starters" to start us thinking about saving and transmitting digital images. During these starters you will work alone and write observations or questions you have on sentence strips as you think of them. Then we will do a focused investigation in small teams in which each team will have to encode an image in order to transmit it to another team. We will then share what we've learned with each other, and then go on to apply it in the computer lab.
    4. The processes you will go through will be similar to "real" engineering, in which there is no one right answer, and many different solutions can be equally valid. Evaluating tradeoffs and working under constraints are two important engineering processes we will

practice.
5. It's okay if it doesn't come easy. If you get stuck, it's okay--take a drink, walk around and look at what the other teams are doing. Getting stuck is natural and usually a sign that a real break-through is about to happen. It means you're pushing the boundaries of you're learning.
6. The role of the facilitators is to guide your learning and help you figure out what and how you want to investigate, not to tell you what's going on.

4. Show rough schedule.
5. Introduce the specific engineering task to be undertaken today
    1. E.g., "You're all going to get an image. You will have to make some sort of measurements in order to describe this picture using numbers and/or letters.
    2. "Eventually you will need to create your own 'image file' and turn another group's measurements into a picture."
6. Pass out the images and design goal/engineering task sheets
    1. "Take five minutes to brainstorm about how you would turn this picture into a 'file'/set of numbers."
    2. "Now we're going to do some 'research activities'/'thinking tools' to give you some ideas about how you'll complete this task. "
    3. "There are four stations set up and numbered around the room..."
    4. "Each of you have a number on your nametag, one through four. When I say to, go to the labeled station that matches the number on your nametag. You will have ten minutes at that station, and you will then rotate around the room in a clockwise fashion."
    5. "Go!""

3 Thinking Tools (i.e., "Starter" activities)

(9:25-10:05)—*40 min. (Katie, Chris, Ian, Elisabeth)*

1. All four starters are done in parallel, rotating every 10 minutes.
2. Have a floater hang up sentence strips as they are generated throughout the Starter process.
3. If only three facilitators are available, Starter 1 can be done with the class as a whole and the students can then rotate between the last three Starters
4. The floater (or a facilitator) should ring a bell at the end of each ten-minute activity

4 Starter 1: Flags

Communicating in pairs to draw a copy of a flag

<u>Order:</u> Do this starter in parallel with the other starters
<u>Facilitator:</u> Katie
<u>Time:</u> 10 min.
<u>Grouping:</u> Each group must have 2 students, so N = # of students / 2. An observer floater pairs with an odd-numbered person.
<u>Materials:</u>

- Various obscure flags, printed one per 8.5"x11" page. Download flags from http://inquirydesign.atwiki.com/file/open/21/flags.ppt.pdf.

- N sets of rainbow colored markers (red/orange/yellow/green/blue/purple/black per set)
- N*2 manilla file folders
- N blank white 8.5"x11" pages
- Blue tack or masking/duct tape
- N*5 sentence strips

Set-Up:
Place one flag in each of N manilla file folders. Place one blank sheet of paper in each of N manilla file folders. Hand each pair of students a file folder with a flag, a file folder with a blank sheet of paper, and a set of colored markers. Give the students sentence strips for writing questions or observations.

Have a floater hang up sentence strips as they are generated throughout the Starter process.

Strategy:
Pair the students with a neighbor and hand each pair the materials.

1. Directions:
    1. "Do not look into the manilla folder until I say it's okay."
    2. "You each have a copy of a flag. One partner will describe the flag and the other partner will draw it."
    3. "Rules: Both partners may speak to each other. Neither one may look at the other's paper. You only have a few minutes."
    4. "Go!" (Facilitator watches clock and gives them 3-4 minutes total.)
2. After students are done drawing flags:
    1. "One member from each team needs to stick the original flag and the drawing to the wall over here with this tape/tack."
    2. "Look at your flag as well as your classmates' flags. Without talking (so that they are your own ideas), write questions/observations on sentence strips."
    3. Things for facilitator to write on sentence strips if students don't come up with them:
        i. *Well-defined shapes like stripes or triangles were easier to transmit than vague shapes like tree or shield.*
        ii. *It is hard to explain a complicated picture in words.*
        iii. *The color of blue in the marker was not the same color of blue in the flag.*

5 Starter 2: One image many pixellation and grayscale ways

Examining several images of the moon, each with different spatial or grayscale resolution

Order: Do this starter in parallel with other starters
Facilitator: Chris
Time: 10 min.
Grouping: N = # of students / 3
Materials:

- Images printed on paper of the moon at different spatial resolution
- Images printed on paper of the moon at different gray resolution
- N magnifying glasses
- N*5 sentence strips
- N markers

Set-Up:
Arrange the images face-up on a table or taped to a wall so that students can walk by and look at each of them. Pass out magnifying glasses, markers, and sentence strips to students. Give the students sentence strips and markers for writing questions or observations.

Have a floater hang up sentence strips as they are generated throughout the Starter process.

Strategy:

1. Directions:
    1. All of these images are of the same object but how the image has been recorded is different
    2. Examine each of the images, use the magnifying glass if necessary.
    3. Record your observations about how the image changes.
    4. Look for changes in the level of detail.
    5. What advantages and disadvantages can you think of for the different ways of recording the image?
    6. Be sure to write whatever other questions, thoughts, observations you have on the sentence strips.
2. Things for facilitator to write on sentence strips if students don't come up with them:
    1. *The dark parts all blend together and the light parts all blend together.*
    2. *The number of colors is changing.*
    3. *The craters are harder to see when it is all the same color.*
    4. *When the pixels are really big I can't see what it is.*
    5. *Can't see the pixels in the image that looks most like the real moon.*
    6. *Becomes harder to see details as pixels get larger.*
    7. *Edge becomes less round when fewer pixels.*

6 Starter 3: Photometer playground

Learning what the photometer measures and how to use it without introducing measurement bias

Order: Do this starter parallel with starters 1, 2, and 4.
Facilitator: Katie
Time: 10 min.
Grouping: There are 8 photometers, so N = 8
Materials:

- Images printed on paper of grayscale gradients
- 3 light bulbs (different wattages: 40, 100, 300W)
- 3 bulb holders
- 3 power strips to screw light bulbs into and to act as a switch
- Extension cords
- N photometers
- N light boxes, made of the following:
    - N cardboard boxes, of approximate size 17.5"x11.5"x9.5" (the kind used to hold reams of printer or photocopier paper), without the lids
    - N pieces of transparent plexiglass, must be larger than the approximately 17.5"x11.5"

box openings
    - N 100-W light bulbs
    - N bulb holders
    - N powerstrips
        - To build a light box: Place one powerstrip, light bulb, and bulb holder in each box. Place a piece of plexiglass on the top of each box.
- N*5 sentence strips
- N markers

Set-Up:
On one or two (adjacent) table(s), plug in each of the bulbs about 5 feet (or more) apart from each other. Give each student a photometer. Set up the N light boxes around the room. Give the students sentence strips and markers for writing questions or observations.

Have a floater hang up sentence strips as they are generated throughout the Starter process.

Strategy:

1. *(5 min.)* First have all students come together around the 3 different-wattage bulbs, and hand each a photometer. Directions:
    1. "Do not talk, so that these are your own questions/observations."
    2. "These light bulbs are 40W, 100W, and 300W. More watts means brighter means more photons. Point the photometer at each bulb and think about what the photometer measures. Write questions/observations on sentence strips."
    3. "Now try moving the photometer closer to and farther away from one bulb. Watch the reading. Write questions/observations on sentence strips."
    4. "Now try tilting the photometer at an angle towards and away from the bulb. Watch the reading. Write questions/observations on sentence strips."
    5. "Write any other questions you may have on a sentence strip."
2. *(5 min.)* Now move to the light boxes. Give each student a couple of pages with gradients printed on them. Directions:
    1. "Do not talk, so that these are your own questions/observations."
    2. "Switch on the light in your light box. Use the photometer to measure what happens when you use darker versus lighter squares to block the light."
    3. "Write your questions/observations on sentence strips."
3. Things for facilitator to write on sentence strips if students don't come up with them:
    1. *The photometer measures light levels.*
    2. *The distance between the bulb and the photometer affects the reading.*
    3. *The angle between the bulb and the photometer affects the reading.*
    4. *The darkness or lightness of the paper between the bulb and the photometer affects the reading.*

7 Starter 4: One image many file formats

Being exposed to different file formats/standards

Order: Do this starter in parallel with starters 1 and 2 and 3
Facilitator: Ian

Time: 10 min.
Grouping: N=8
Materials:

- Images & ASCII/hex printed on paper of a smiley face in six different file formats (SVG, EPS, PGM, FITS, PNG, JPEG)
- If available, several laptops/computers:
  - loaded with the “happy” images
  - along with the software to view the images, such as the Gimp or
    - IrfanView for PC
    - Preview, Graphic Converter, and Ds9 for Mac
  - and software to view the text
    - a text editor
  - and a hex editor, such as
    - Neo for PC or
    - 0xED for Mac
- N*5 sentence strips
- N markers

Set-Up:
Arrange the pages with the images and their corresponding text (ascii or hex) happy-face-up on tables. These images are arranged into six 'mini-stations' with several copies of each file format; this forces the students to move around the starter area and better encourages them to interact and discuss their observations

If available, also have the laptops on and open, with the folder containing the images open and the images
open in imaging software and text. Give the students sentence strips and markers for writing questions or
observations.

Have a floater hang up sentence strips as they are generated throughout the Starter process.

Strategy:

1. Directions:
   1. On this computer, and printed out on these pages, are what look like several copies of the same image. However, each image has actually been saved in a different file format -- that is, the computer uses different data to represent each file. The back of each page shows the computer code representing that file; you can also view this on the computers.
   2. Take these papers and take turns at the computers and take a look at these different representations.
2. Arrange the pages with the images and their corresponding text (ascii or hex) happy-face-up on tables.

   If available, also have the laptops on and open, with the folder containing the images open and the images
   open in imaging software and text. Give the students sentence strips and markers for writing questions or

observations.

3. Have stimulating questions prepared to ask the students if they have nothing to say themselves.
    1. For example:
    2. What are the advantages/disadvantages of some of these formats?
    3. How does format X "work?"
    4. Which of these formats would be good/bad for a particular task (representing a drawing, a photograph, using small amounts of disk space, capturing high levels of detail, etc.)
4. Things for facilitator to write on sentence strips if students don't come up with them:
    1. *All the pictures look the same even though the text/numbers are different.*
    2. *Some image files are ascii and others are hex.*
    3. *Imaging software shows the pictures while text/hex editor software shows the numbers.*
    4. Pictures are numbers.

8 Break and Sentence-Strip Organization

Order: Day 1 after the starters 1-4.
Facilitators: All
Time: 15 min.
Grouping: No groups
Materials:

- The following category headings (or other categories, as appropriate) written on sentence strips:
    - Transmitting images
    - Spatial information
    - Color/grayscale information
    - Image file formats
    - Measuring light levels with a photometer
    - Tradeoffs
    - Other
- Large, tear-off easel paper
- Blue tack or masking tape

Set-Up:
During the starters and break, organize the sentence strips into the categories listed above and tape or blue-tack them to the large paper sheets under their category headings. Insert teacher-written sentence-strips if crucial questions/observations were missed by students.

Add the facilitator-made sentence strips if students did not come up with those particular questions/observations.

9 Post-Starters: Starter Synthesis

Order: Day 1 after the break
Facilitators: Chris/All
Time: 15 min.
Grouping: No groups
Strategy:

1. [Discuss the various issues raised in each grouping of sentence strips, highlighting themes and complimenting them on their good questions/observations]
2. [Some comments about what we learned and what ideas started flowing during the starters.]
3. [Discuss how they relate to the upcoming project]

10 Focused Investigation: Image Encoding

Order: Day 1 after the starter synthesis.
Facilitators: All
Time: 65 min.
Grouping: N=8 M=30
Materials:

- N light boxes (the same ones used in Starter 3: See instructions for building them there.)
- M papers w/ an investigation image printed on back where M=total number of students (additional copies needed for jigsaw sharing; only N copies are needed for the focused investigation.)
- N lists of scientific goals (a different one for each group, and appropriate to the image at each light box)
- N lists of the cost-per-character formula
- N rulers
- N compasses
- N protractors
- Color filters and/or cellophane, for any advanced group that gets a color image
- N clear plastic transparencies with pre-printed grids of 0.5", 0.75", 1", 1.25", 1.5" squares
- N card-stock papers with 0.5", 0.75", 1", 1.25", 1.5" square cut-out opening
- Tape (pretty much any kind that doesn't leave residue: Scotch, masking, etc....)
- Stapler

Set-Up:
Spread as far as possible, each team is at a station set up on a 2'x4' desk or so. Place the image next to the set-up. Place all materials (light boxes, photometers, rulers, compasses, protractors, transparencies, color filters, card-stock papers, tape, stapler) on a front table. If possible, one section of the room should be darkened so the photometers see less background light.

Strategy:
Send each group to a station near a light box (although they do not have to use the light box). Each group gets an image, a scientific goal description (http://inquirydesign.atwiki.com/file/open/21/ImageGoals.pdf), and a list of budget rules and constraints. Other materials are available at the front.

1. Timeline:
    1. 0-15 minutes: let the students do things freely, probably considering the schedule/budget.
    2. 20 minutes: make sure that all teams have begun taking at least exploratory data by this point
    3. 50 minutes: warn all groups that only 10 minutes remain

1. Students form teams of 2-3 at the N stations. Let N=the number of teams.

2. Directions:
    1. “Each team has an image, a description of your scientific goals, and a list of budget rules/constraints.”
    2. “Your task is to encode your image in such a way that another team will be able to draw it. Just like the flag starter, but you will transmit the information in writing rather than speaking.”
    3. “You also have budgetary constraints as follows: ...”
    4. “You are acting like an engineering team that is designing a scientific camera to use for some specific astronomical goal.”
3. Note: For this part I found that setting the photometer dial to the “2mW” scale gave the maximum resolution (3 digits). Facilitators check.
4. Students prepare a final record of their image, including scale information and other header information.
5. Also, need to give lesson on scaling before the first time they try to draw the image.
6. In the end, I found a good set-up as follows: Choose the 1” grid and the 1” square hole (since that fits the photometer nicely). I stapled the transparency-grid to the image so it wouldn’t move around. The purpose of the cardboard page with a square hole cut out is to control radiometry: Tape the cardboard to the storage tub with the square hole directly above the bulb. The measurer has no choice but to move the paper around to fit the place being measured directly above the light (at the hole position). This controls for brightness-vs-distance very nicely.

11 Day 1 closing and homework assignment

<u>Order:</u> Day 1 after the starter synthesis.
<u>Facilitators:</u> Ian
<u>Time:</u> 10 min.
<u>Grouping:</u> No groups
<u>Materials:</u>

- Copies of the day 1 homework assignment to pass out

<u>Strategy:</u>

1. Directions:
    1. "All of you have made and recorded measurements of an image. Your homework assignment for Thursday,which I will pass out in a moment, consists of two parts."
    2. "First, your group will need to meet (or confer by email or telephone) to decide on a way to make a written 'file format' of your image data. This 'file' needs to have all the information necessary for another group to turn the 'file' back into an image again -- because that's exactly what's going to happen on Thursday. Your group will need to consider the tradeoffs and restrictions imposed by the process -- for example, numbers of brightness levels. "
    3. "After deciding on a file format to use and properly writing out your 'file,' each of you are to individually write a description of the various choices you made in your measurements and 'file format' and the reasons for these decisions."
    4. “What questions do you have?"
    5. If no questions, ask one or two students, e.g., “what are you going to bring on Thursday?”
    6. “Be sure to save your nametags (or leave them here) for Thursday.”
    7. Hand out the homework assignment.

12 Introduction to Day 2

Order: Day 2 at the start.
Facilitators: Katie/Ian
Time: 10 min.
Grouping: No groups
Strategy:

1. Get students' attention. Use powerpoint slides as visual aide ("opener_day2.ppt").
2. First collect homework; as day one is briefly reviewed and the second day's activities are introduced, other facilitators quickly look over homeworks to determine which groups will need extra assistance and how many prepared "contingency image files" will need to be distributed (for groups who did not bring in an image file).
3. "Last time we did some starters to get us thinking about the different issues in recording and transmitting images."
4. "Then we encoded an image towards a particular goal."
5. "Today we will attempt to answer the question: is it straightforward to turn a set of numbers into a picture? This happy face seems reasonably simple, but maybe a more complicated image would be more trouble to decipher."
6. "This is definitely a task that's been done in the real world. This picture shows the first picture ever sent back from Mars from the spacecraft Mariner 4. The engineers and scientists at NASA were so eager to see what the planet looked like, they couldn't even wait for the officially released science image. Instead, they printed out the raw numbers sent back by the spacecraft onto strips of paper and colored-by-number to form the first picture. This picture is still hanging at the Jet Propulsion Laboratory in Pasadena, California."
7. "Today you are all going to be 'real-time data encoders,' just like those early NASA engineers."
8. [At this time, pass out image files, which have been properly vetted by the other facilitators.]

13 Focused Investigation 2a: Image Reconstruction

Order: Day 2 at the start.
Facilitators: All
Time: 40 min.
Grouping: N=8
Materials:

- 8.5"x11" paper for drawing
- N rulers
- N protractors
- N compasses
- N papers with pre-printed grids of 0.5", 0.75", 1", 1.25", 1.5" squares
- N sets of pastel chalks, 10 gradations of grayscale
- N sets of pastel chalks, 10 gradations of color

Set-Up:
Pass out the paper and pastel chalks. Leave the other materials at the front for any teams to choose to

use. Give each team an image file from a different team.
As each group finishes reconstructing an image, it is photocopied by an observer/facilitator and handed back to the group that originally encoded it. Individually, groups transition to the next step.

Strategy:

1. Each group receives the record from a neighboring group, and uses the information to reconstruct the image.
2. As needed, groups may verbally request the other group that wrote the record for further clarifying information.
3. Color table is their choice—grayscale or color pastel chalks are available
4. When each group finishes, 3 photocopies are made of:
    1. the 'file format' they used
    2. the image they reconstructed from the 'file format' data
5. This group proceeds to the next step, and the copies are given to the group they originally came from

14 Focused Investigation 2b: Prepare for sharing

Facilitators: Ian/All
Time: 20 minutes
Grouping: N=8
Materials:

- large tear-off sticky papers for presentation posters
- Group's original "science goal" and "budget constraints"
- Group's original "image file" from homework
- Group's image as reconstructed by another team
- Sharing rubrics

Set-Up:
As each group finishes reconstructing an image, it is photocopied by an observer/facilitator and handed back to the group that originally encoded it.
They are given a copy of the sharing rubric, told to write their name on it, and to prepare for the sharing activity.

Strategy:

1. Give each student :
    1. a copy of the rubric,
    2. a large sticky note for writing upon
    3. a copy of their written 'file format' (the homework assignment)
    4. a copy of the image another group reconstructed from this group's 'file format'
2. Directions:
    1. "You will all have three minutes to present your image, your decisions about turning it into a file, and any reflections based on the image the other group reconstructed from your 'file'."

15 Jigsaw Sharing

Facilitators: All
Time: 30 minutes
Grouping: three groups, each with a member from each engineering team
Strategy:

1. "Each of you will have three minutes to :
   1. "Share your image and goal, and your encoding process and choices."
   2. "Show and describe your image file format choice"
   3. "Demonstrate good communication skills."
   4. "[Maybe] comment on whether you met your budget or not."
2. "This is exactly what you will do as a leader of an engineering team. Any large engineering project will have many 'design reviews,' in which you have to convince the project managers that you know what you're doing and that they shouldn't cancel your project altogether."
3. Facilitators evaluate students based on rubric

16 Synthesis, Closing, and Post-Activity Homework

Order: Day 2 at the end
Facilitators: Chris
Time: 20 min.
Grouping: No groups
Materials:

- Feedback forms

Strategy:

1. Get students' attention. Use powerpoint slides as visual aide ("synthesis.ppt").
2. Lecture on content goals, following the slide content. Generally address the following topics:
   1. Pictures are numbers
   2. Grayscale and bit-depth
   3. Image file formats and header information
   4. Basic image manipulation and processing techniques
3. Pass out the final lab report assignment. Discuss it, then ask questions to ensure that the students understand what they need to do.
4. Hand out feedback forms; take five minutes for students to fill them out.
5. As students finish feedback forms, they can leave.

17 Bonus activity: Image exploration/manipulation on computers

To be done only if you have an additional day, or extra class time to fill!

Time: 35 minutes
Materials:

- N computers, Microsoft Windows operating system, with pre-loaded software:
  - (1) Any text editor (i.e. Notepad)

- (2) IrfanView (www.irfanview.com—a fast, free, easy download)
- (3) Free Hex Editor Neo (http://www.hhdsoftware.com/Products/home/hex-editor-free.html)

- Handouts of example .pgm image file (see Appendix)

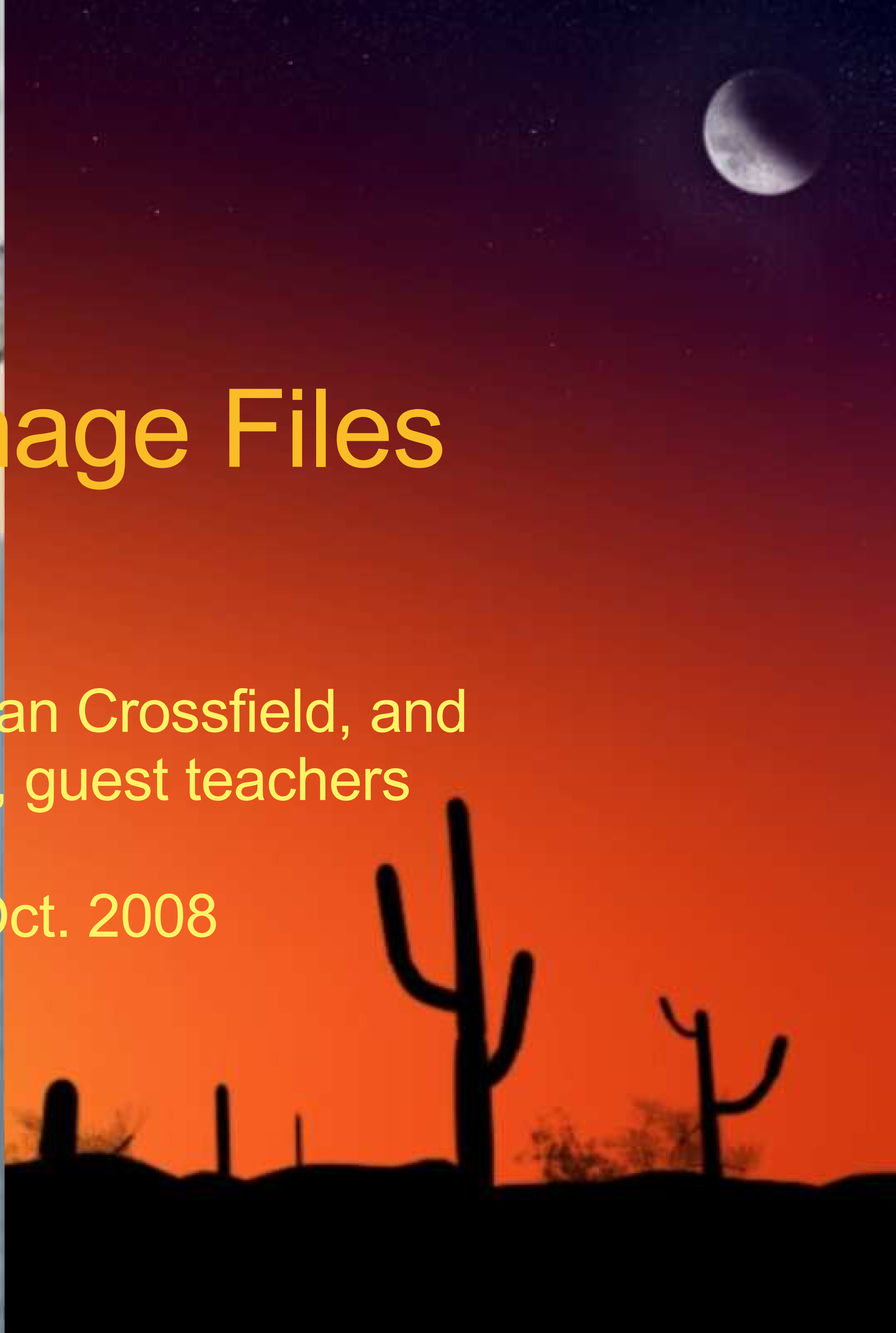
Set-Up:

Each computer should be pre-loaded with the Gimp; PCs should also have Hex Editor Neo and Macs 0xED for Hex editing (these are all freely available on the Internet).

Strategy:

Pass out handouts about .pgm digital image file format.

1. Students type their image into the computer, using the pgm format.
2. Ask students (at computers) to make the entire image darker by manipulating the numbers.
3. Share how they did this.
4. Now that they are started, have students complete assessment worksheet.



Digital Image Files

Katie Morzinski, Ian Crossfield, and Chris Crockett, guest teachers

21-23 Oct. 2008

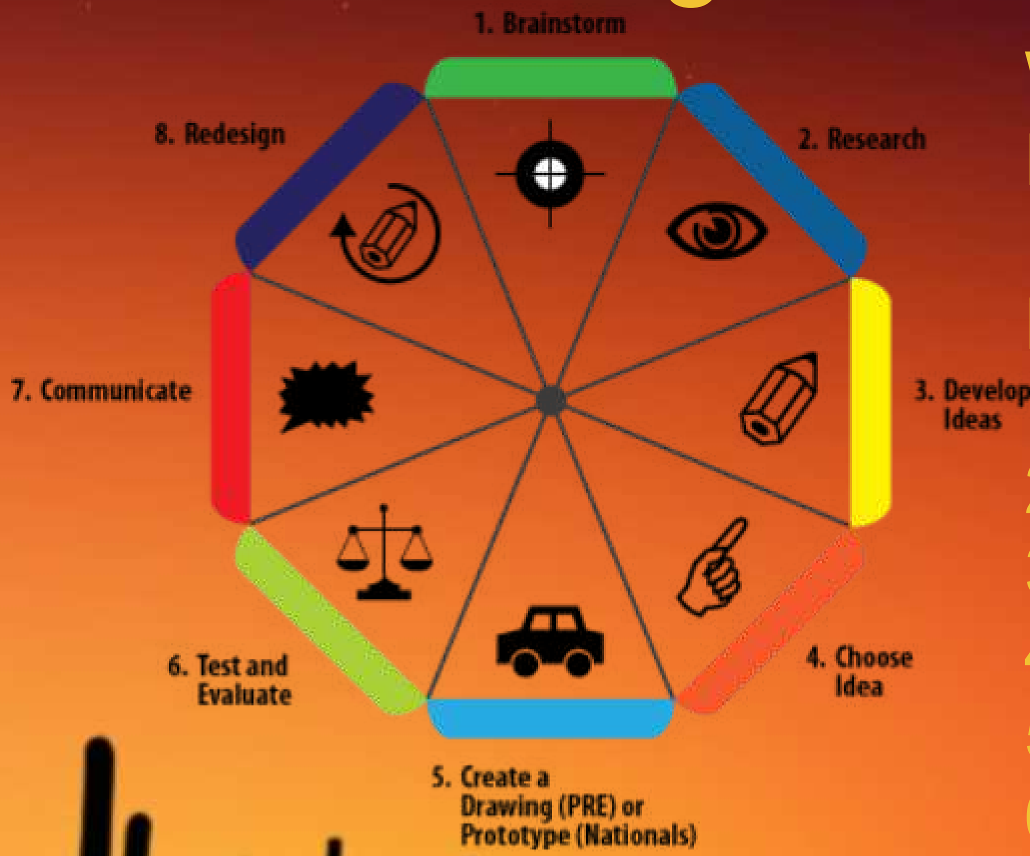
Digital images are a way to save, store, and transmit pictures

- Why take pictures?
- Why save pictures?
- Why transmit pictures?
- Why store pictures?

Digital images are pictures. Pictures contain information.

- What kinds of information are **not** recorded with a picture?
- What kinds of information do pictures contain?
- How is a digital camera different from an old-fashioned film camera?

We will be practicing the principles and process of engineering



Working within **constraints**
Evaluating **trade-offs**

Engineering Design Process

1. Brainstorm
2. Research
3. Develop Ideas
4. Choose Idea
5. Create a Prototype
6. Test and Evaluate
7. Communicate
8. Redesign

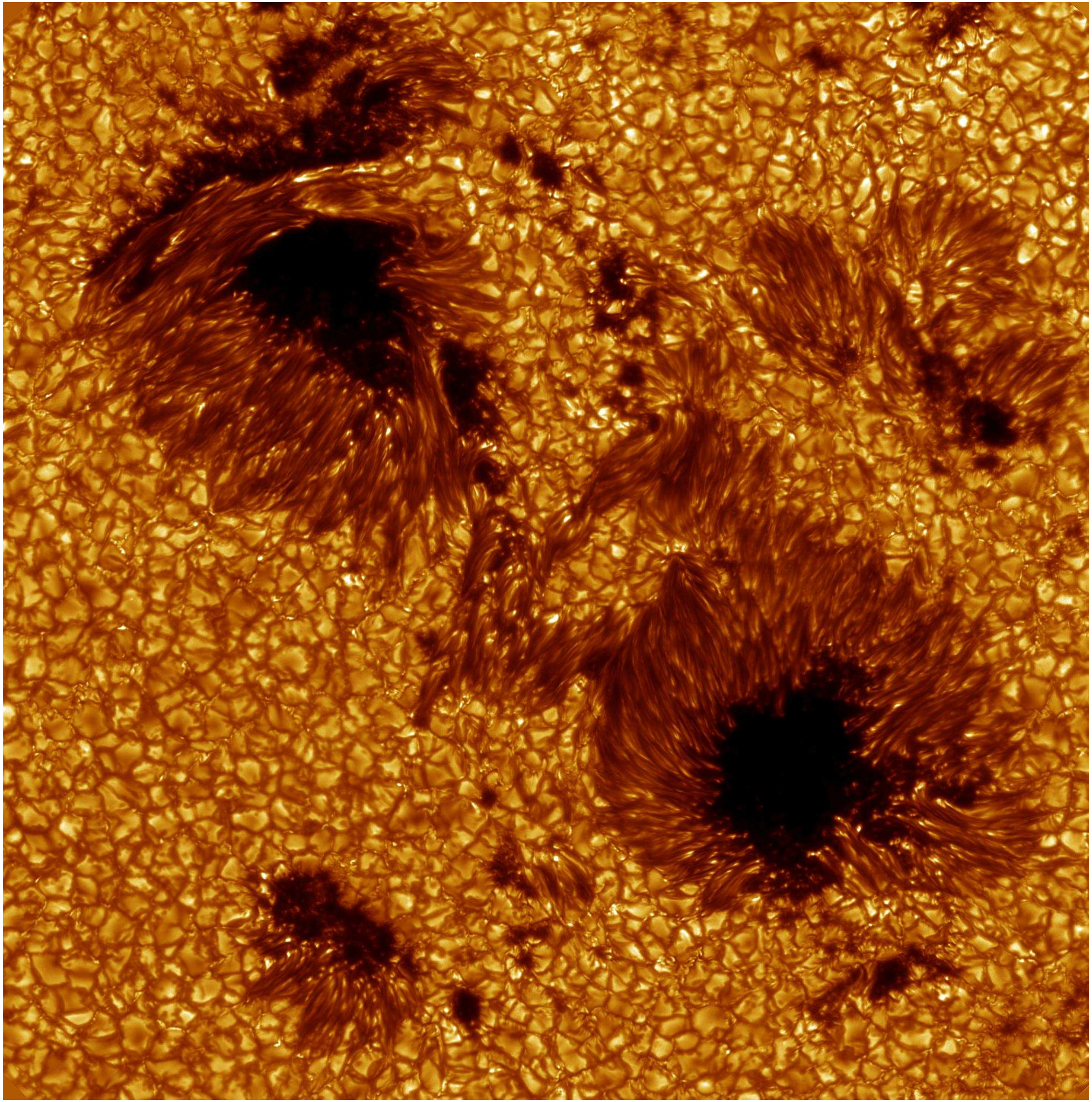
Today and Thursday we will be investigating digital image files

- You will be presented with a problem and will need to devise a solution of your own design (with a team)
- You will share out your solution as well as the thought processes that brought you there
- Inquiry can be a frustrating process--much like real engineering--okay if solution doesn’t come easily
- Getting stuck is natural and usually a sign that a major breakthrough in understanding is about to happen

Today and Thursday we will be investigating digital image files

Schedule:

- Day 1:
  - Starters (40 min.)
  - Investigation 1--Image encoding (60 min.)
- Homework
- Day 2:
  - Investigation 2--Image decoding (30 min.)
  - Sharing (30 min.)
  - Investigation 3--Computer image manipulation (30 min.)
  - Synthesis (20 min.)
- Homework



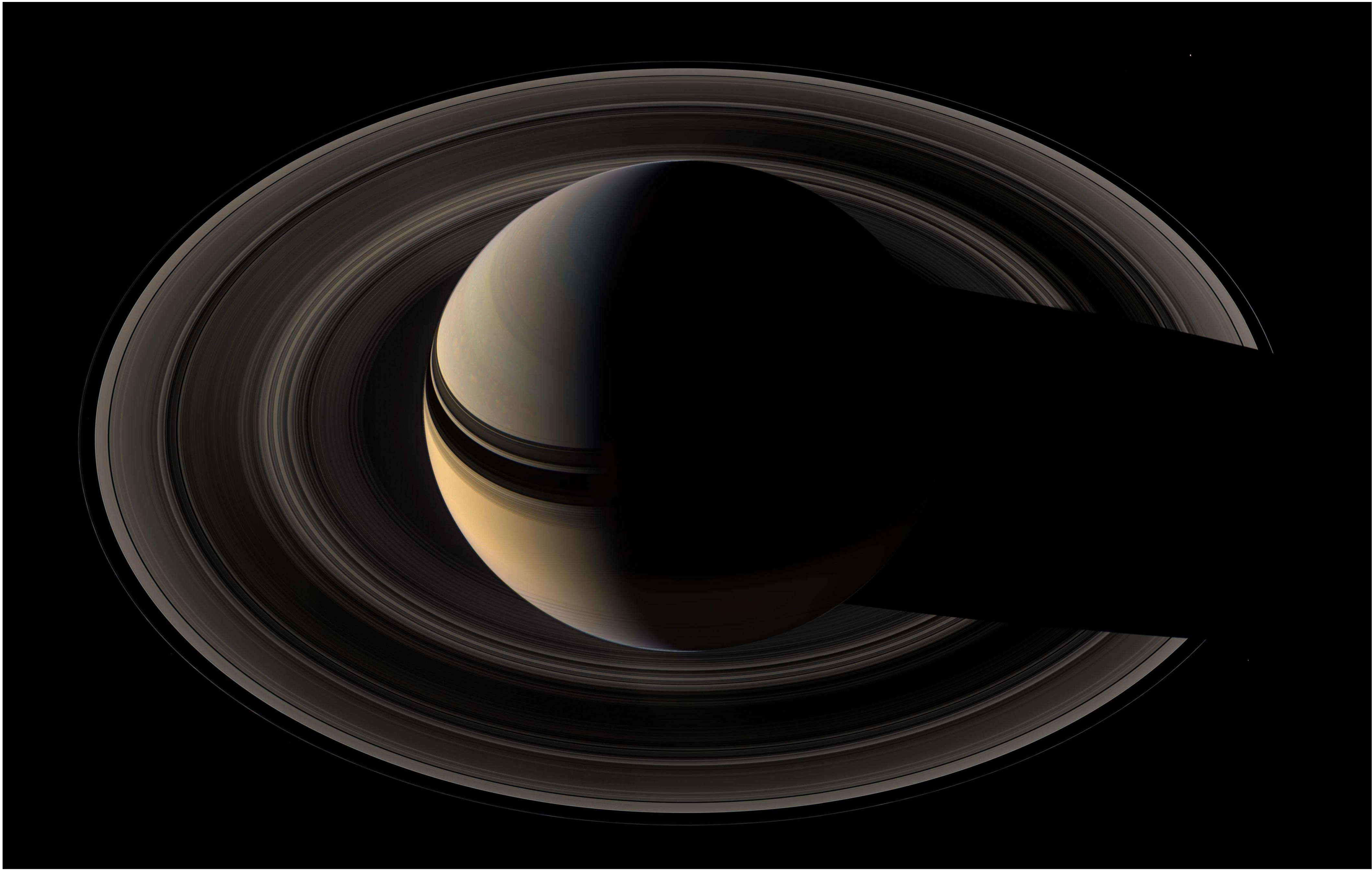


Image: Sun with sunspots (S)

Overall scientific goal: Differential rotation rate of sun

Intermediate step: Map of location of sunspots

Description:

You are a member of an engineering team. Your team is working on a project to study the rotation rate of the sun. The sun's equator does not rotate at the same rate as the sun's poles; this is called *differential rotation*. The image you have is a close-up picture of some of the sun's sunspots, take with the Swedish 1-m Solar Telescope on the Canary Island La Palma in 2002. The sunspots remain present on the surface of the sun long enough to rotate around the sun at least once, so they can be used to measure the differential rotation rate.

Your task is to come up with a way to digitize this image that transmits sufficient information for the differential rotation rate of the sun to be measured. Think of it as designing an instrument to measure and record images of the sun, with the goal of measuring the differential rotation rate. Do this by digitizing this image of the sun in a way that allows another group to reconstruct the image towards the goal of measuring the differential rotation rate of the sun.

Image: Sun with sunspots (G)

Overall scientific goal: Temperature of sunspots with respect to the photosphere

Intermediate step: Brightness of sunspots with respect to the photosphere

Description:

You are a member of an engineering team. Your team is working on a project to study the temperature of the sun's sunspots. A sunspot is a large dark region on the surface of the sun with a high magnetic field that slows down convection that would normally bring hot material to the sun's surface. Consequentally, sunspots are cooler in temperature than the surrounding area (called the photosphere). The image you have is a close-up picture of some of the sun's sunspots, take with the Swedish 1-m Solar Telescope on the Canary Island La Palma in 2002. The temperature of the sunspots with respect to the photosphere is related to the darkness of the sunspots with respect to the bright photosphere.

Your task is to come up with a way to digitize this image that transmits sufficient information for the temperature of the sunspots with respect to the photosphere to be measured. Think of it as designing an instrument to measure and record images of the sun, with the goal of measuring the sunspot temperature. Do this by digitizing this image of the sun in a way that allows another group to reconstruct the image towards the goal of measuring the temperature of the sunspots.

Image: Full moon (S)

Overall scientific goal: Relief topography (elevation) of the moon

Intermediate step: Mapping maria and terrae

Description:

You are a member of an engineering team. Your team is working on a project to create a map of relief topography (elevation) of the moon. As a first-order approximation, the darker areas (*maria*, or "seas") are lower in elevation, and the lighter-colored areas (*terrae*, or "highlands") are higher in elevation. This is due to the fact that the lower-elevation areas were filled with volcanic lava which then cooled, leaving behind darker-colored basalt rock. The image you have of the near side of the moon was taken with the Galileo robotic spacecraft in December 1992. A photograph of the moon is an image of reflected light across the moon's surface.

Your task is to come up with a way to digitize this image that transmits sufficient information for the maria and terrae to be mapped. Think of it as designing an instrument to measure and record images of the moon, with the goal of mapping the topography. Do this by digitizing this image of the moon in a way that allows another group to reconstruct the image towards the goal of mapping the topography of the moon.

Image: Full moon (G)

Overall scientific goal: Temperature of different surface rock on moon

Intermediate step: Albedo of different surface rock on moon

Description:

You are a member of an engineering team. Your team is working on a project to study the temperature of different surface rock on the moon. If sunlight falls on the rock with the same intensity and angle, then darker rock will have a higher temperature. Therefore, temperature of the rock is related to its brightness, or *albedo*. Albedo is the fraction of light reflected by an object (Albedo = Amount of Reflected Light / Amount of Incident Light). The image you have of the near side of the moon was taken with the Galileo robotic spacecraft in December 1992. A photograph of the moon is an image of reflected light across the moon's surface.

Your task is to come up with a way to digitize this image that transmits sufficient information for the albedo of the moon to be measured. Think of it as designing an instrument to measure and record images of the moon, with the goal of measuring the temperature. Do this by digitizing this image of the moon in a way that allows another group to reconstruct the image towards the goal of measuring the albedo of the moon.

Image: Jupiter (S)

Overall scientific goal: Rotation period of Jupiter

Intermediate step: Mapping locations of cloud features

Description:

You are a member of an engineering team. Your team is working on a project to study the rotation period of Jupiter. The planet's visible surface consists of clouds at different altitudes. These clouds are rotating in different rates and directions around Jupiter: some eastward, some westward. Meanwhile, the planet as a whole is rotating, more rapidly than the clouds' speeds. The image you have of Jupiter was taken by the Cassini robotic spacecraft in December 2000. One way to measure the rotation period of Jupiter is to measure the locations of some prominent cloud features at different times, then take the average to be the rotation period.

Your task is to come up with a way to digitize this image that transmits sufficient information for the rotation rate of Jupiter to be measured. Think of it as designing an instrument to measure and record images of Jupiter, with the goal of measuring the rotation rate. Do this by digitizing this image of Jupiter in a way that allows another group to reconstruct the image towards the goal of mapping the locations of cloud features.

Image: Jupiter (G)

Overall scientific goal: Height of cloud layers

Intermediate step: Brightness/darkness of cloud layers

Description:

You are a member of an engineering team. Your team is working on a project to study the height of cloud layers on Jupiter. The lighter-colored bands are called *zones* and the darker bands are called *belts*. The zones are colder and are likely gas that has ascended to higher altitudes. The belts are warmer and are likely gas that has descended to lower altitudes. The image you have of Jupiter was taken by the Cassini robotic spacecraft in December 2000. The brightness and darkness of the cloud layers can be used to determine the high and low altitude clouds.

Your task is to come up with a way to digitize this image that transmits sufficient information for the brightness of the clouds to be measured. Think of it as designing an instrument to measure and record images of Jupiter, with the goal of measuring the relative heights of the cloud layers. Do this by digitizing this image of Jupiter in a way that allows another group to reconstruct the image towards the goal of measuring the brightness of the cloud layers.

Image: Jupiter (C)

Overall scientific goal: Chemical composition of Jupiter's atmosphere

Intermediate step: Colors of cloud features

Description:

You are a member of an engineering team. Your team is working on a project to study the chemical composition of Jupiter's atmosphere. The planet's visible surface consists of clouds of different color, altitude, and chemical composition. The image you have of Jupiter was taken by the Cassini robotic spacecraft in December 2000. Color gives clues about the chemical composition of the clouds.

Your task is to come up with a way to digitize this image that transmits sufficient information for the cloud colors of Jupiter to be measured. Think of it as designing an instrument to measure and record images of Jupiter, with the goal of measuring the chemical composition of the clouds. Do this by digitizing this image of Jupiter in a way that allows another group to reconstruct the image towards the goal of determining the chemical compositions of cloud features.

Image: Saturn (S)

Overall scientific goal: Studying ring structure of Saturn

Intermediate step: Mapping rings of Saturn

Description:

You are a member of an engineering team. Your team is working on a project to study the ring structure of Saturn. The ring structure (locations, gap size, gap locations) is set somewhat by Saturn's moons, and therefore studying the rings is important for understanding dynamics of the moons. The image you have of Saturn was taken by the Cassini robotic spacecraft in May 2007. The rings are visible due to reflected light from the sun.

Your task is to come up with a way to digitize this image that transmits sufficient information for the ring structure of Saturn to be mapped. Think of it as designing an instrument to measure and record images of Saturn's rings, with the goal of studying the structure. Do this by digitizing this image of Saturn in a way that allows another group to reconstruct the image towards the goal of mapping the ring structure.

Image: Saturn (G)

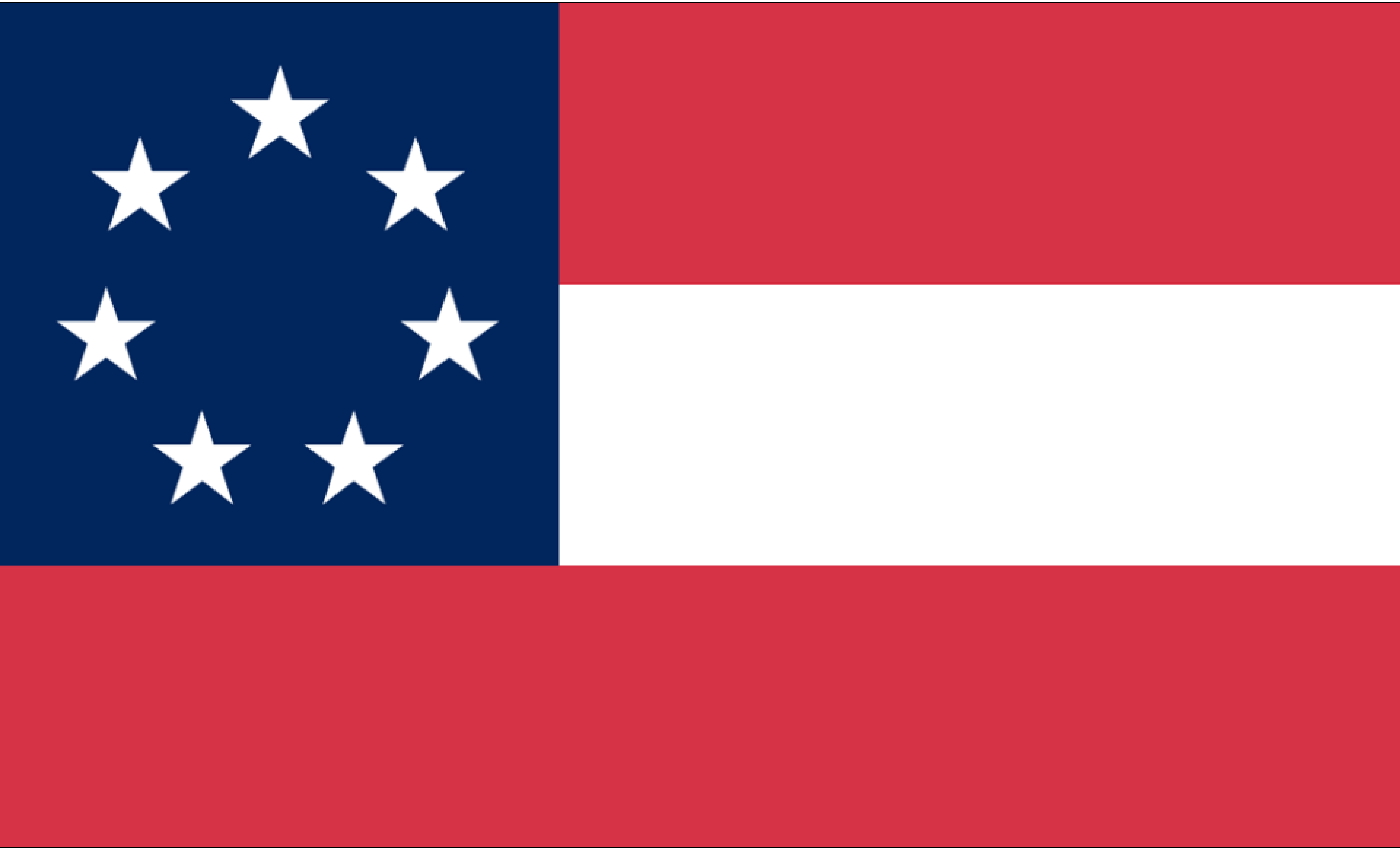
Overall scientific goal: Chemical composition of Saturn's rings and atmosphere

Intermediate step: Albedo of rings and atmosphere of Saturn

Description:

You are a member of an engineering team. Your team is working on a project to study the composition of Saturn's rings and atmosphere. The brightness, or *albedo*, can be measured to help study composition. Albedo is the fraction of light reflected by an object (Albedo = Amount of Reflected Light / Amount of Incident Light). The image you have of Saturn was taken by the Cassini robotic spacecraft in May 2007. Different chemical species have different albedos; therefore, the albedo can be used as a first approximation for composition.

Your task is to come up with a way to digitize this image that transmits sufficient information for the albedo of the rings and atmosphere of Saturn to be measured. Think of it as designing an instrument to measure and record images of Saturn, with the goal of measuring the chemical composition. Do this by digitizing this image of Saturn in a way that allows another group to reconstruct the image towards the goal of measuring the albedo.

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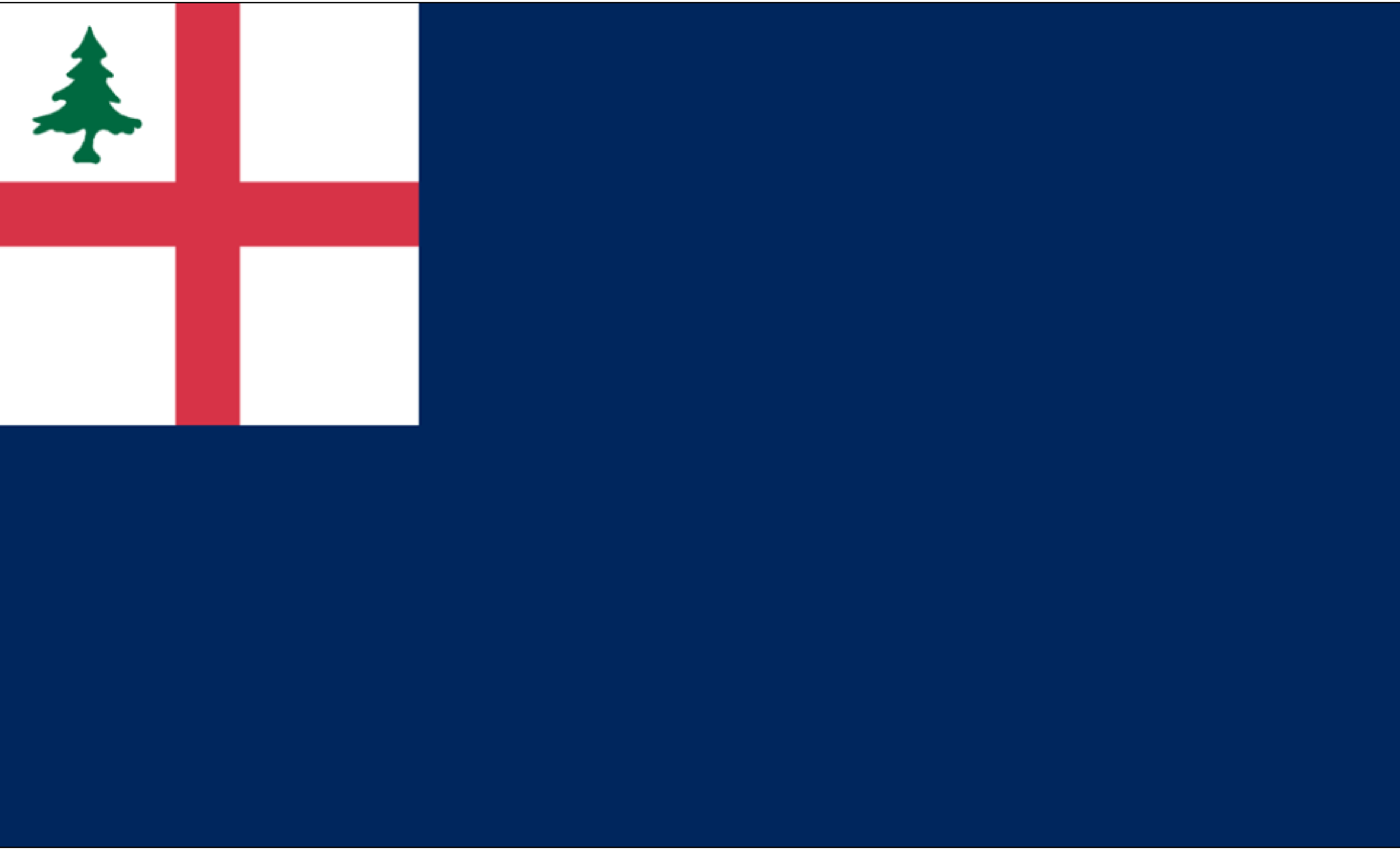
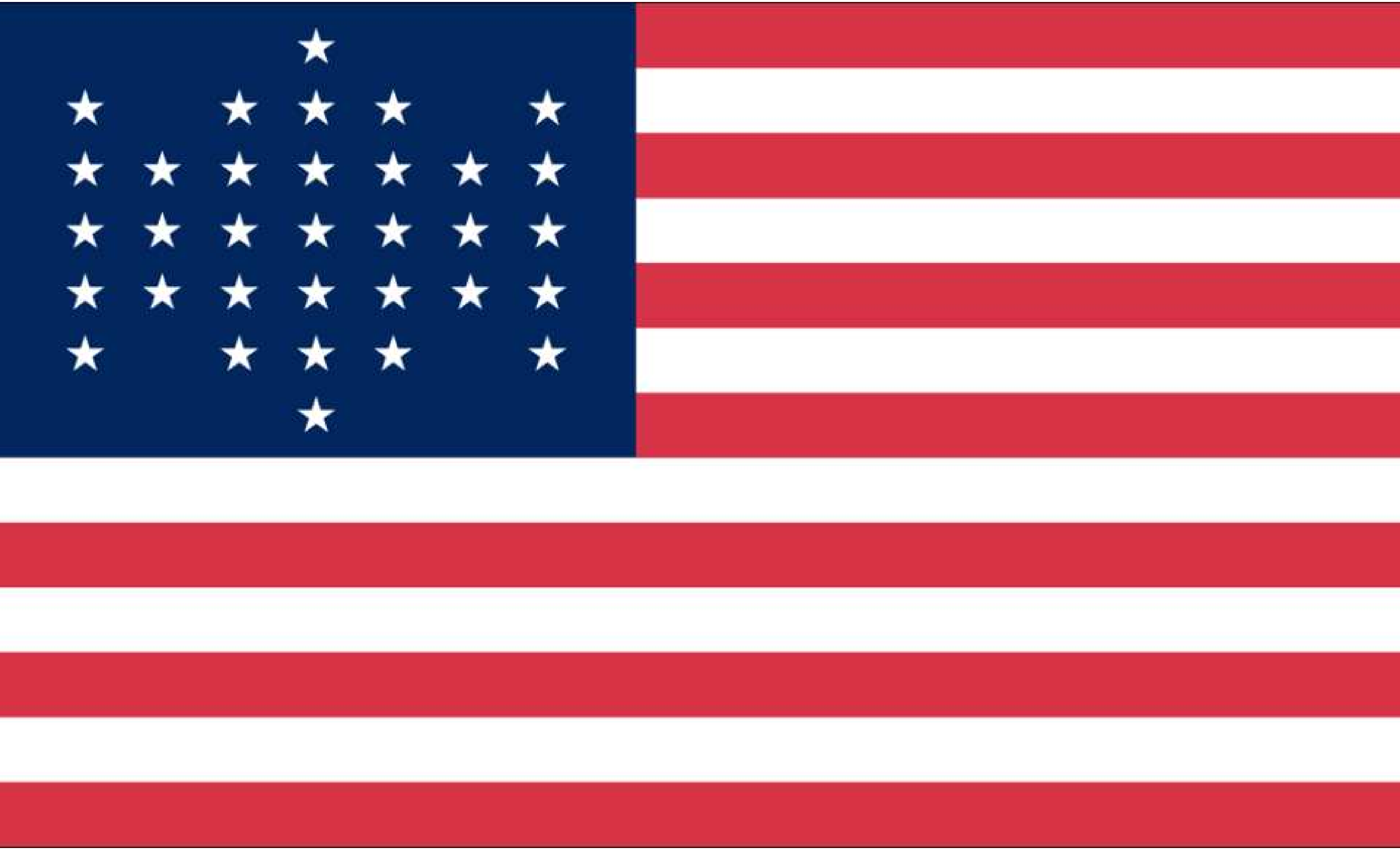
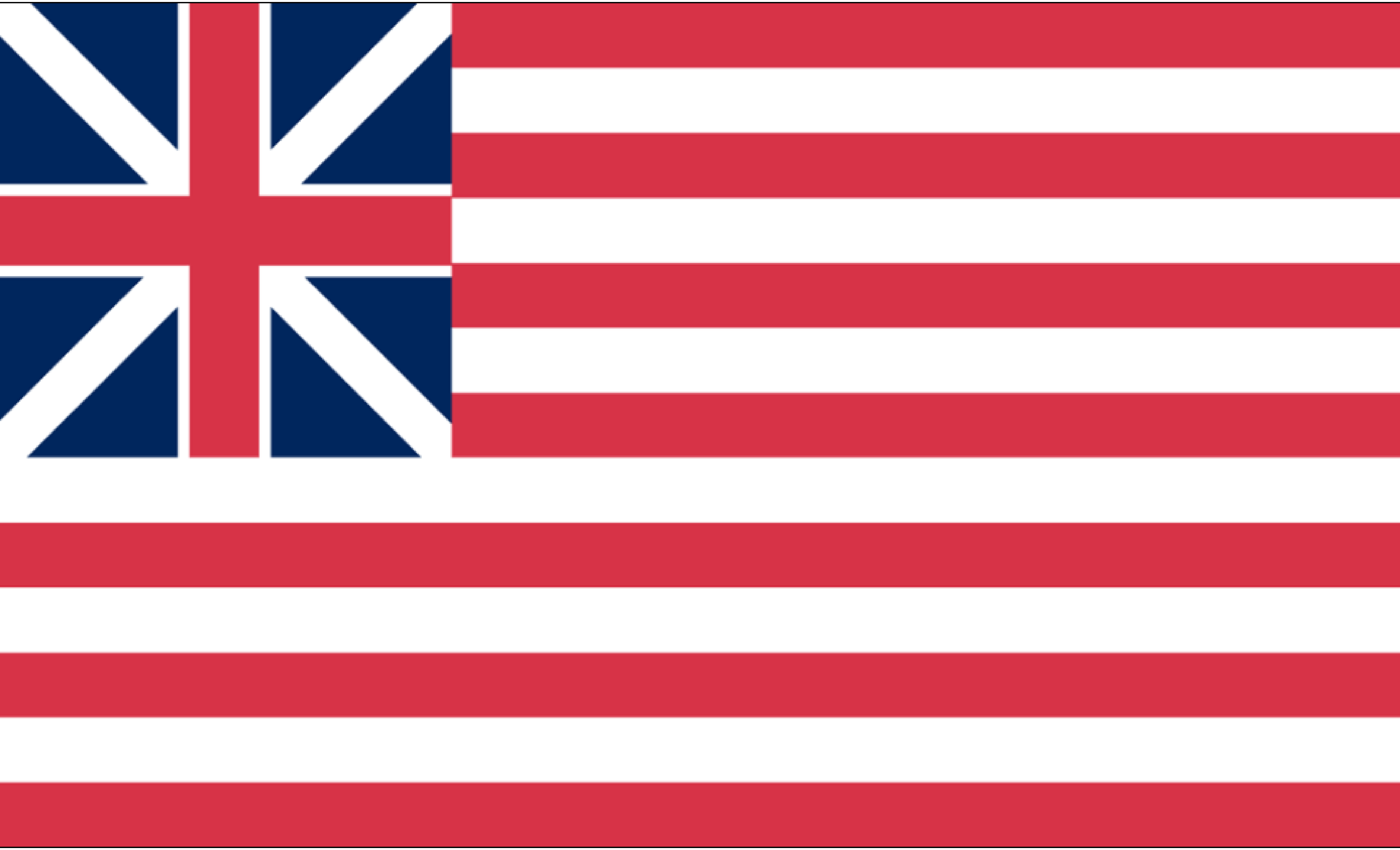
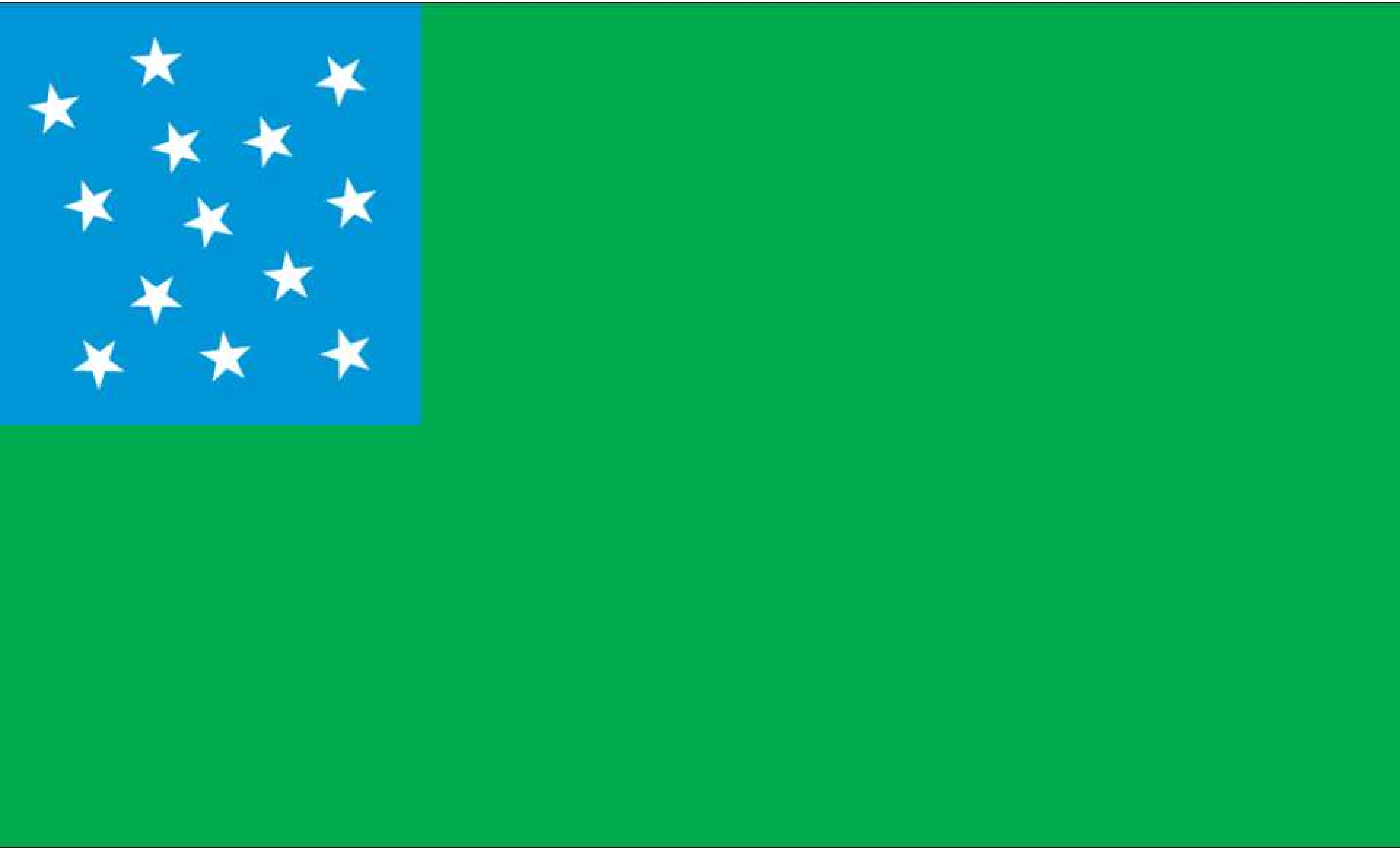


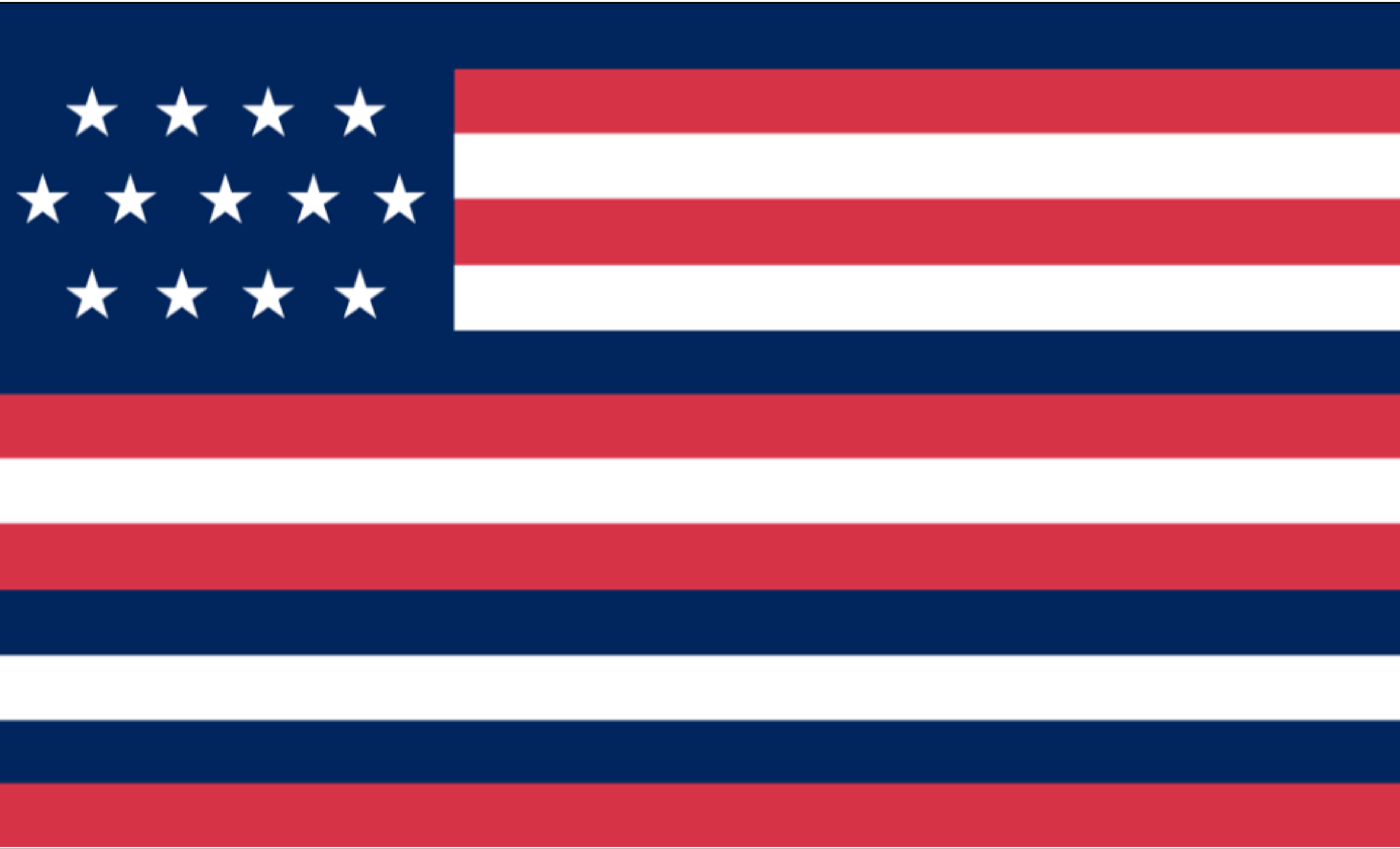

THE CULPEPER MINUTE MEN
LIBERTY OR DEATH
DONT TREAD ON ME

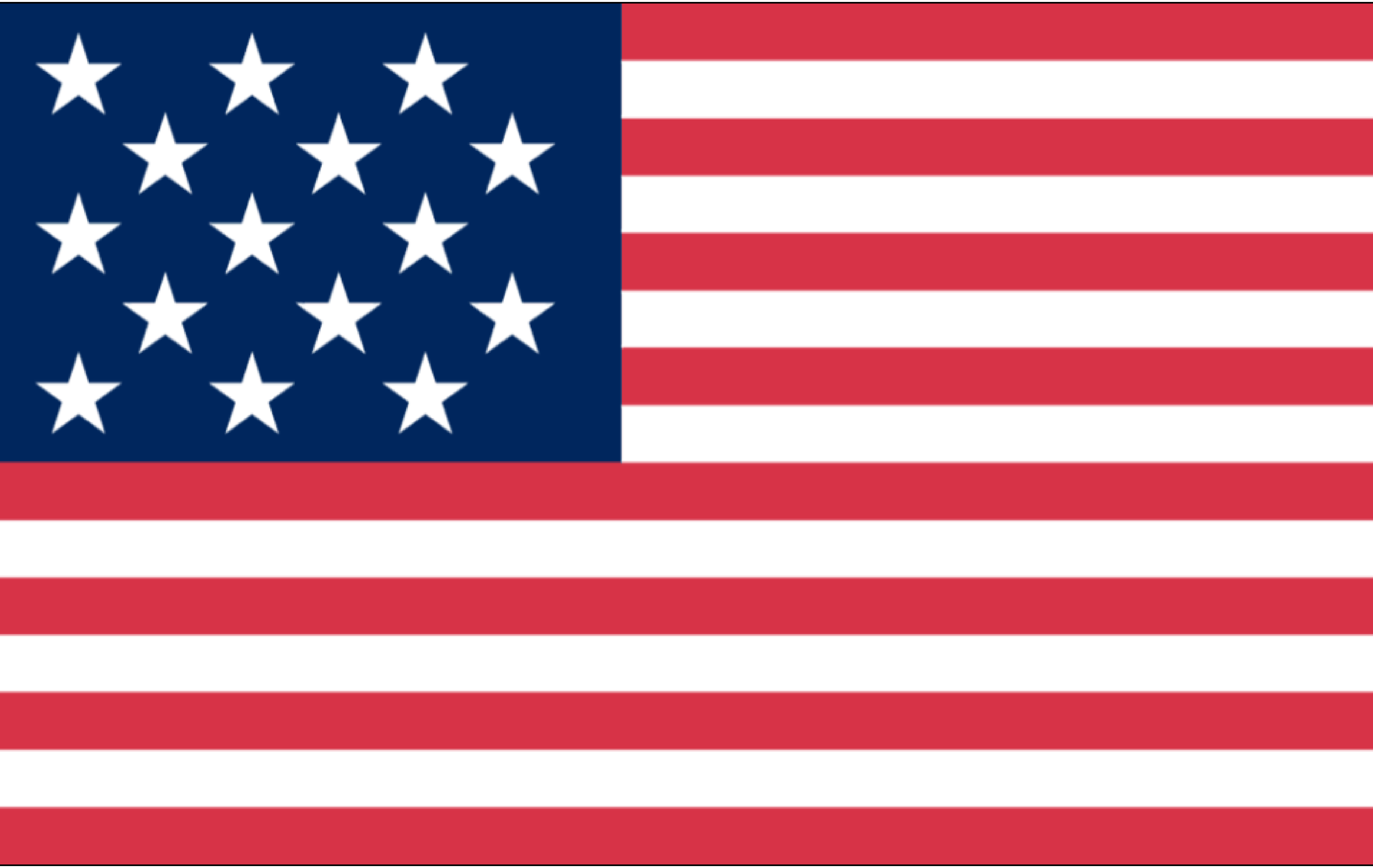


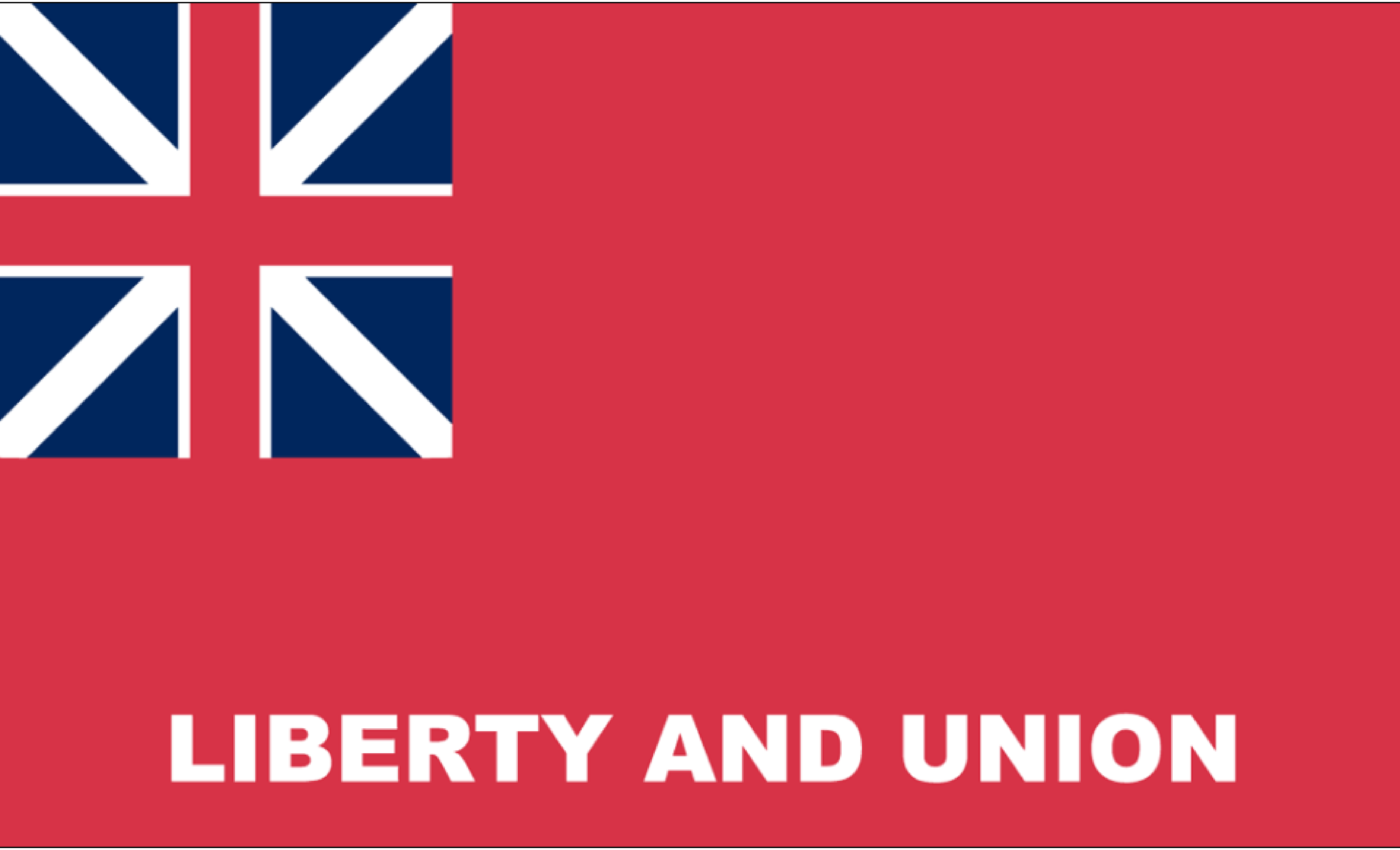

DONT TREAD ON ME










LIBERTY AND UNION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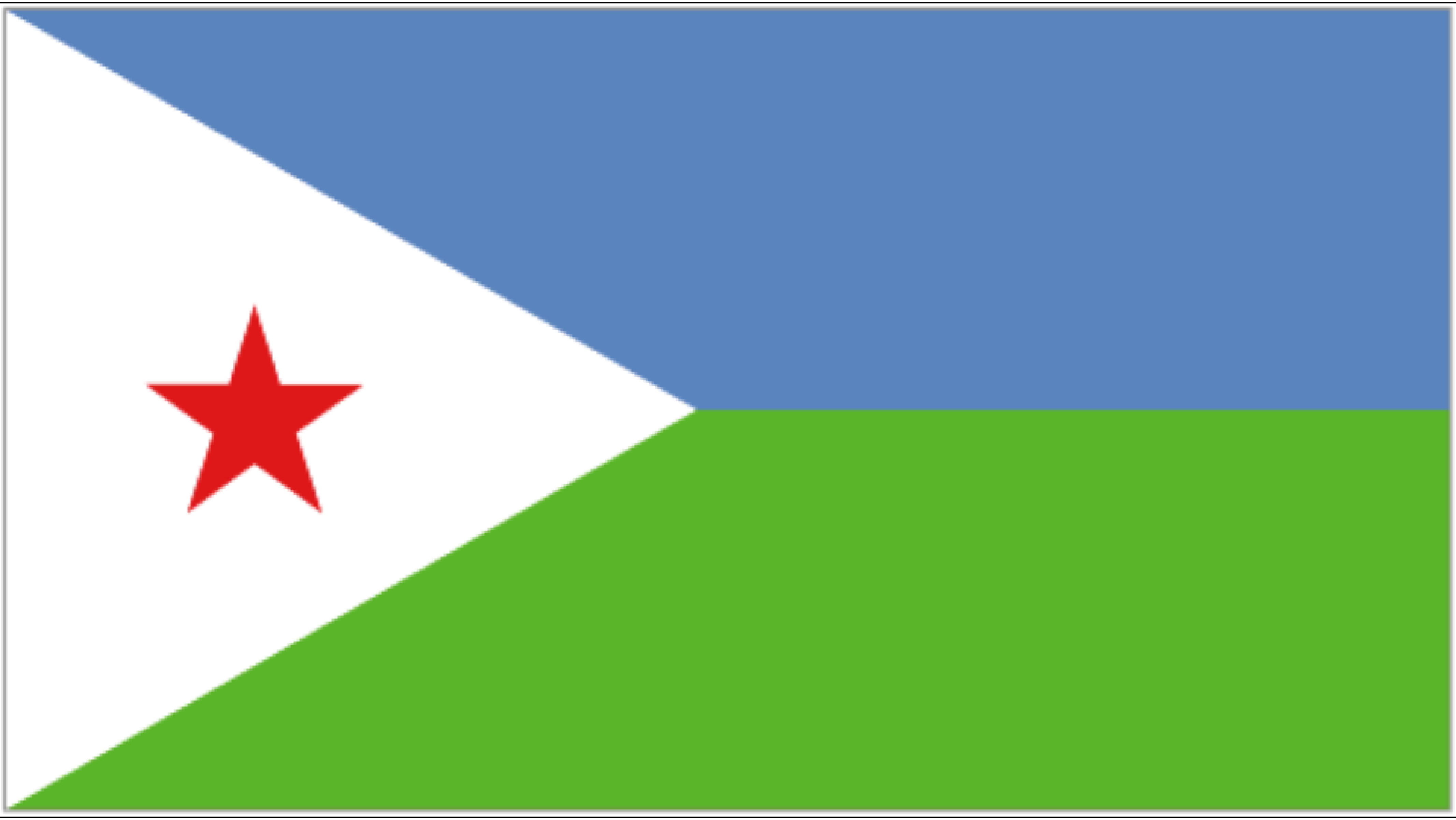
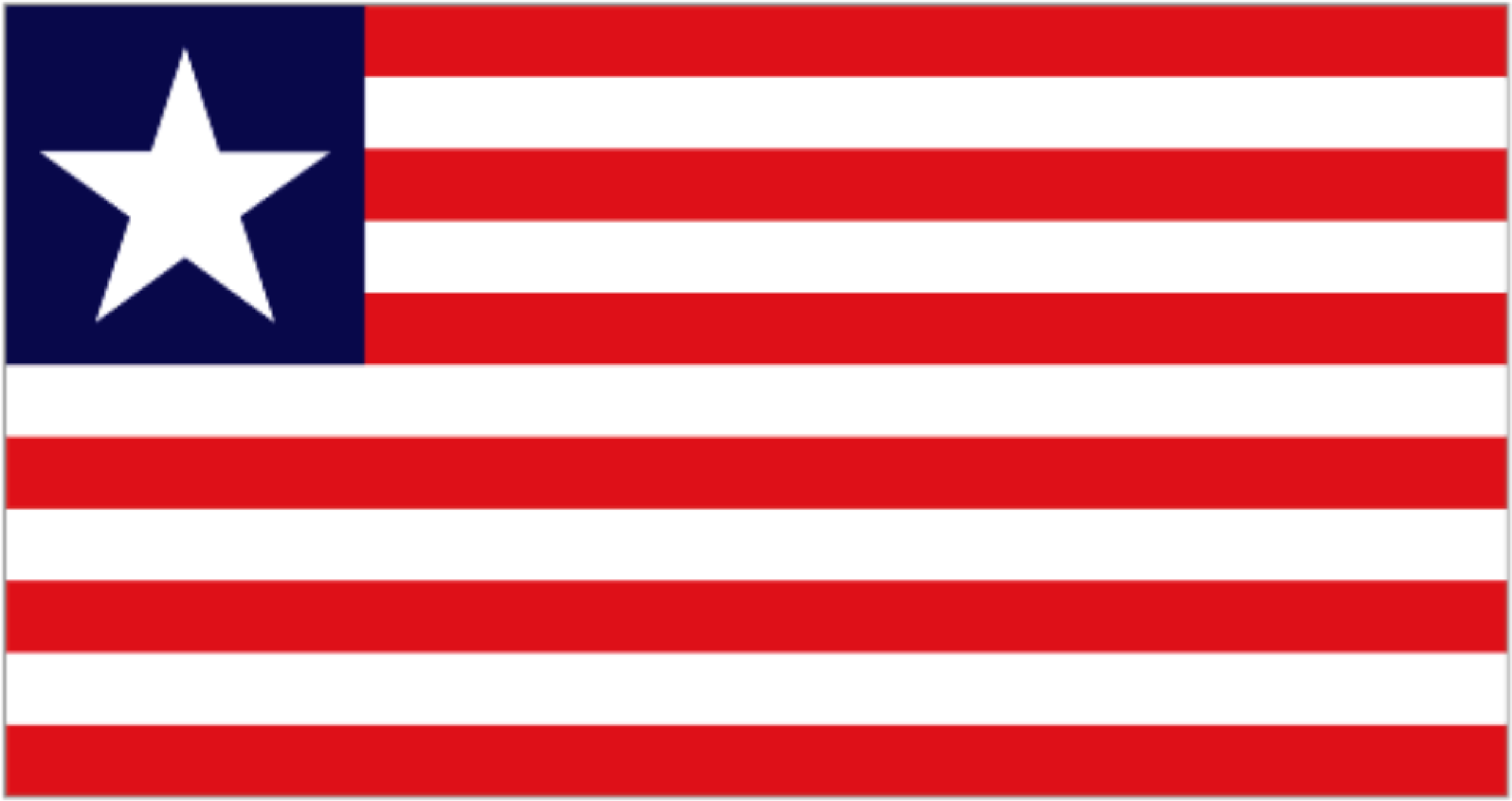
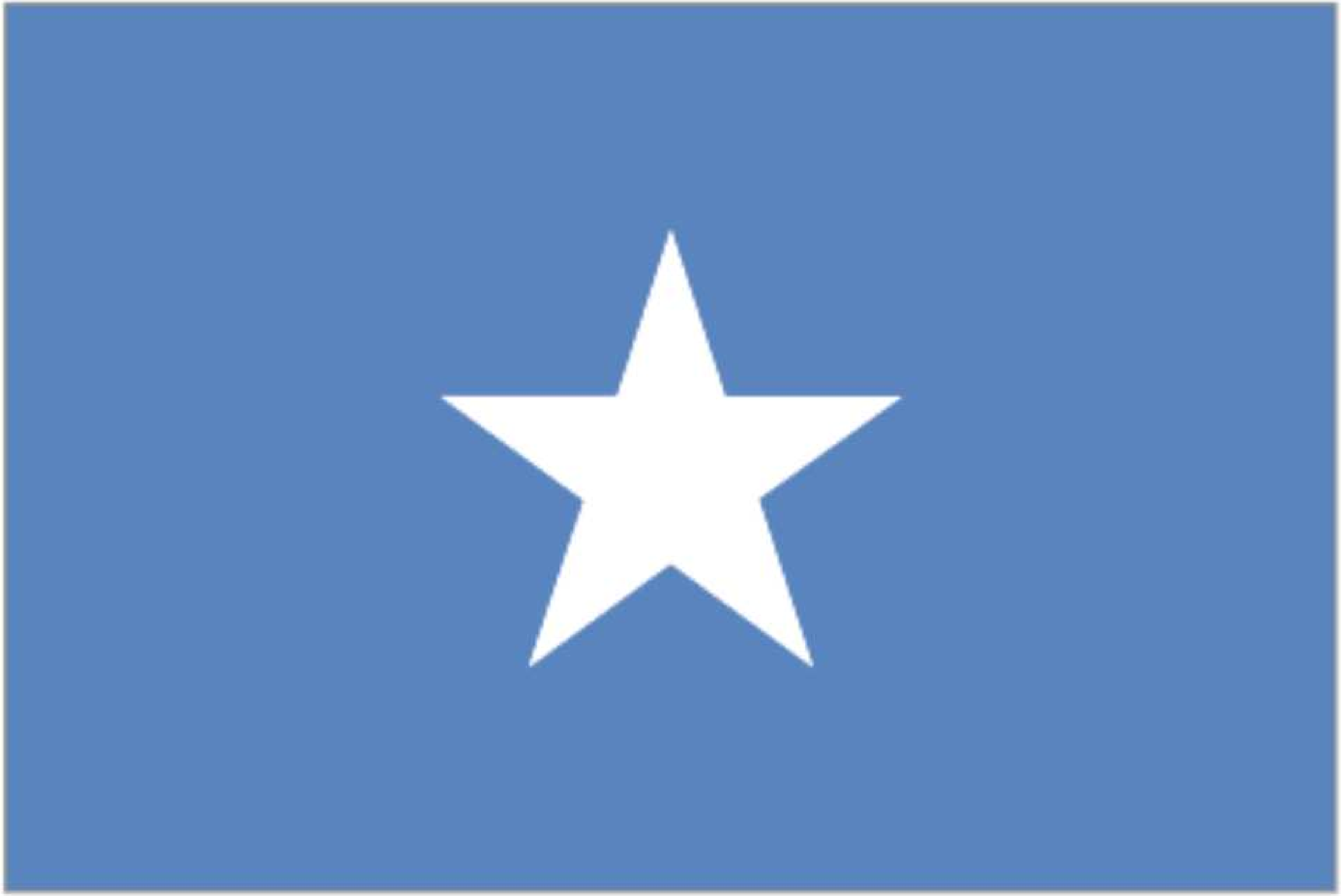
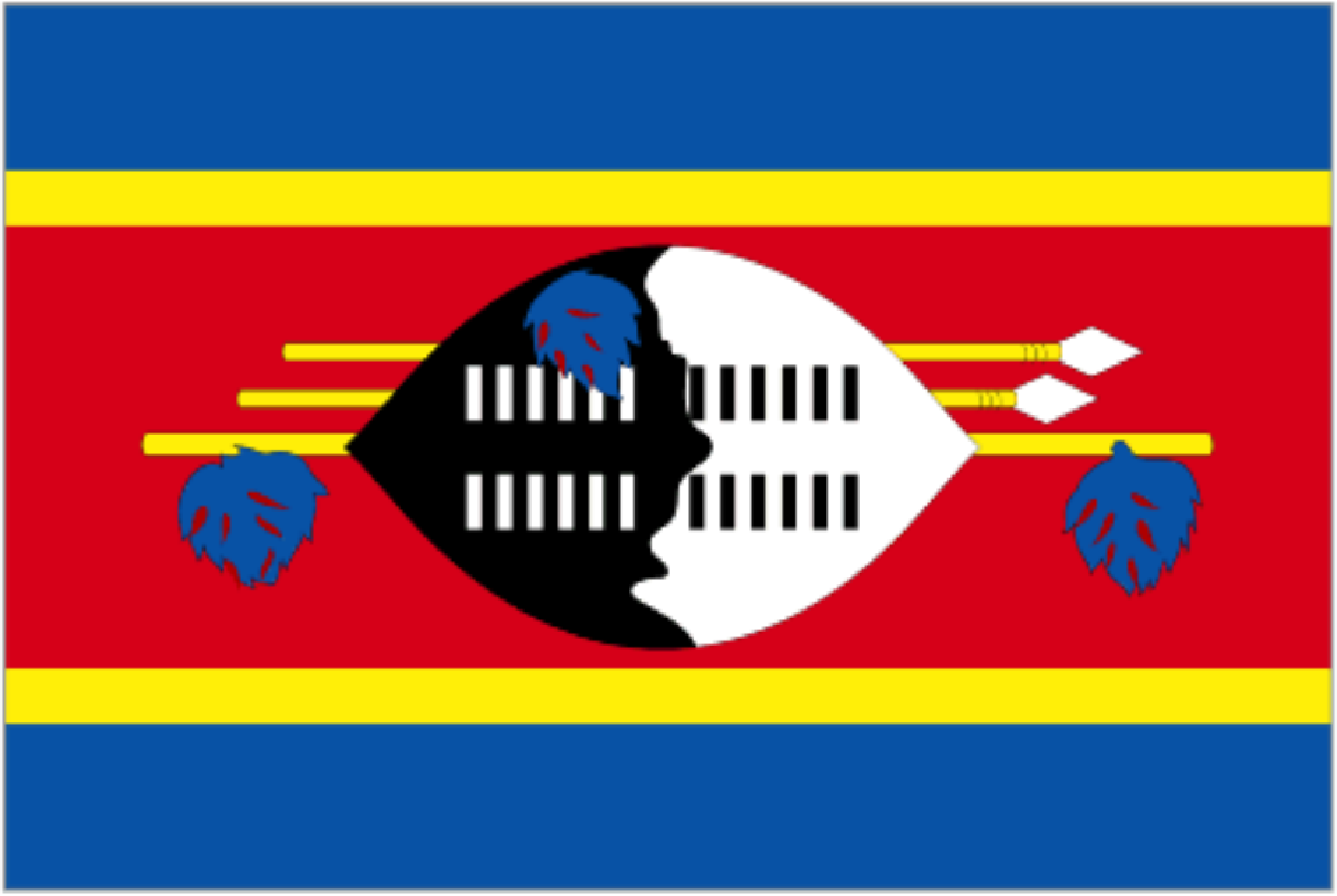
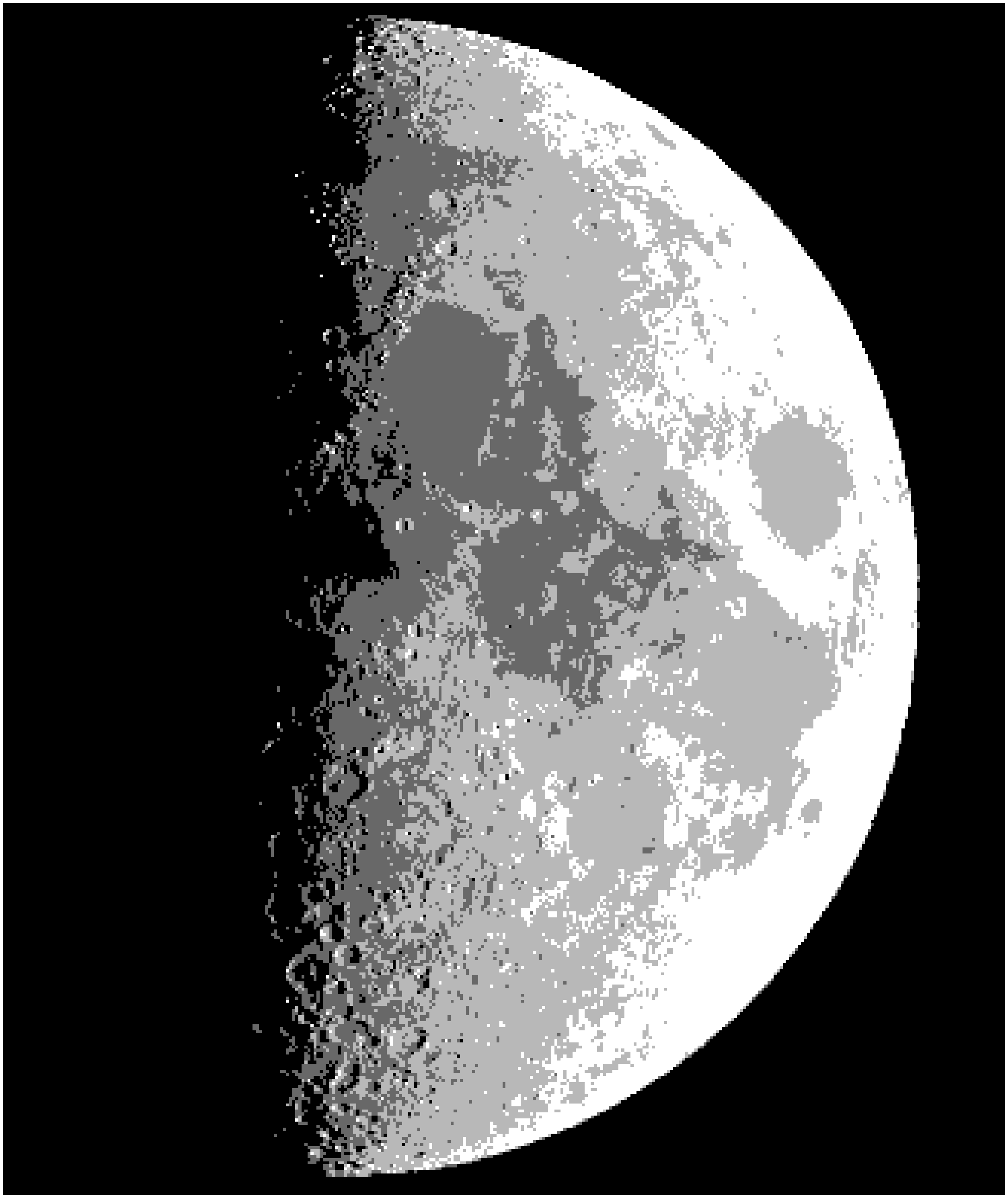
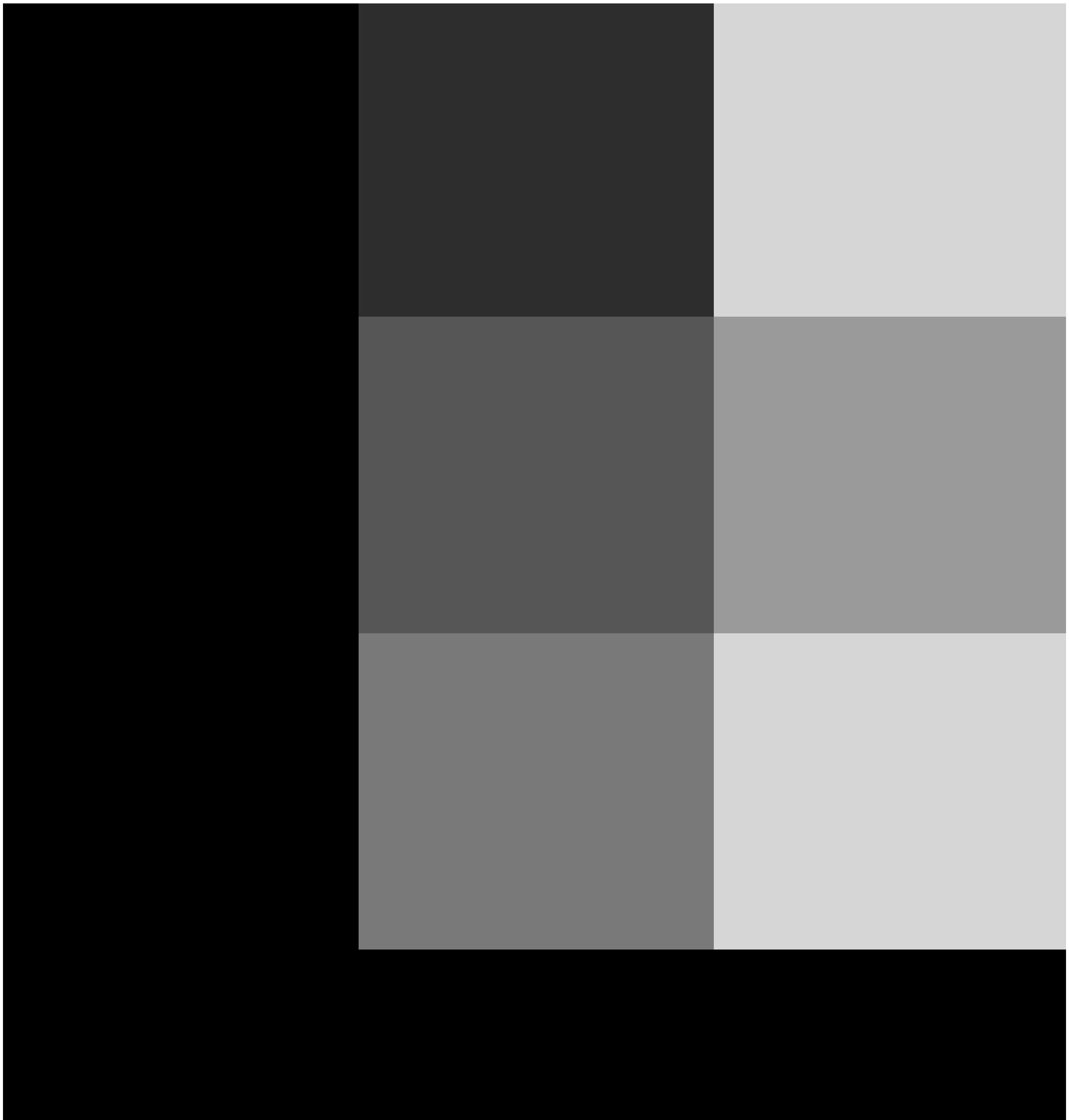


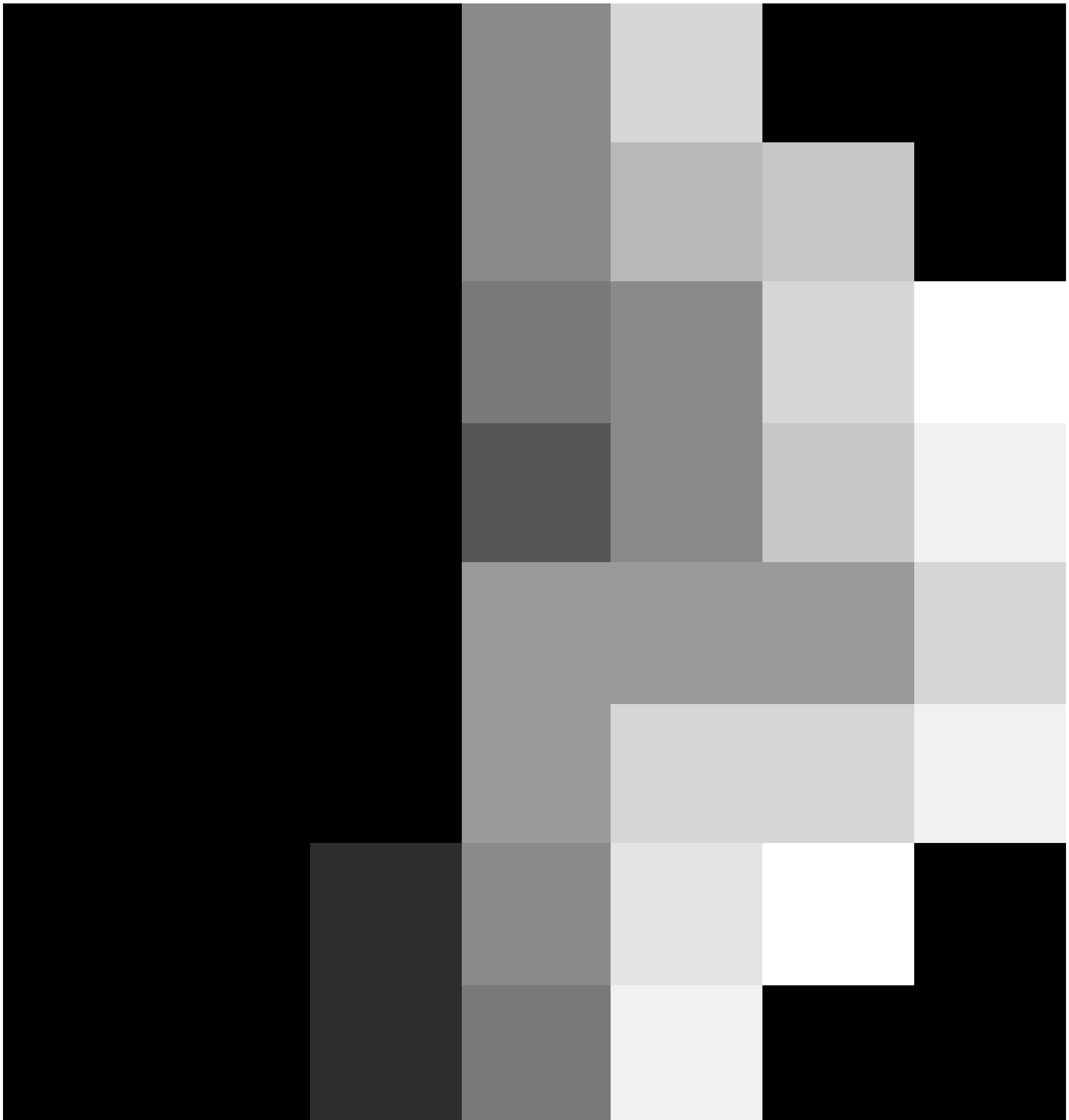


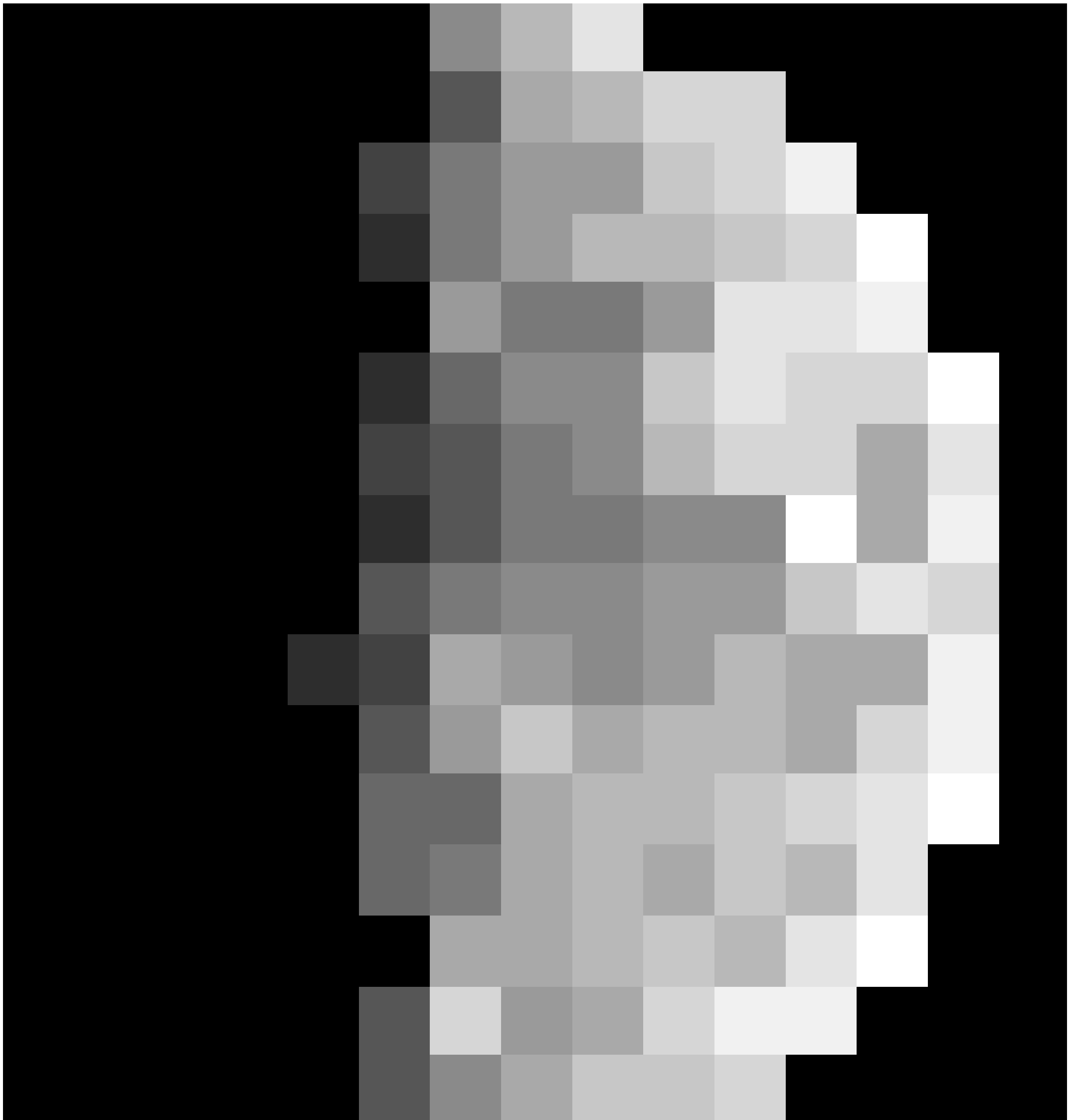


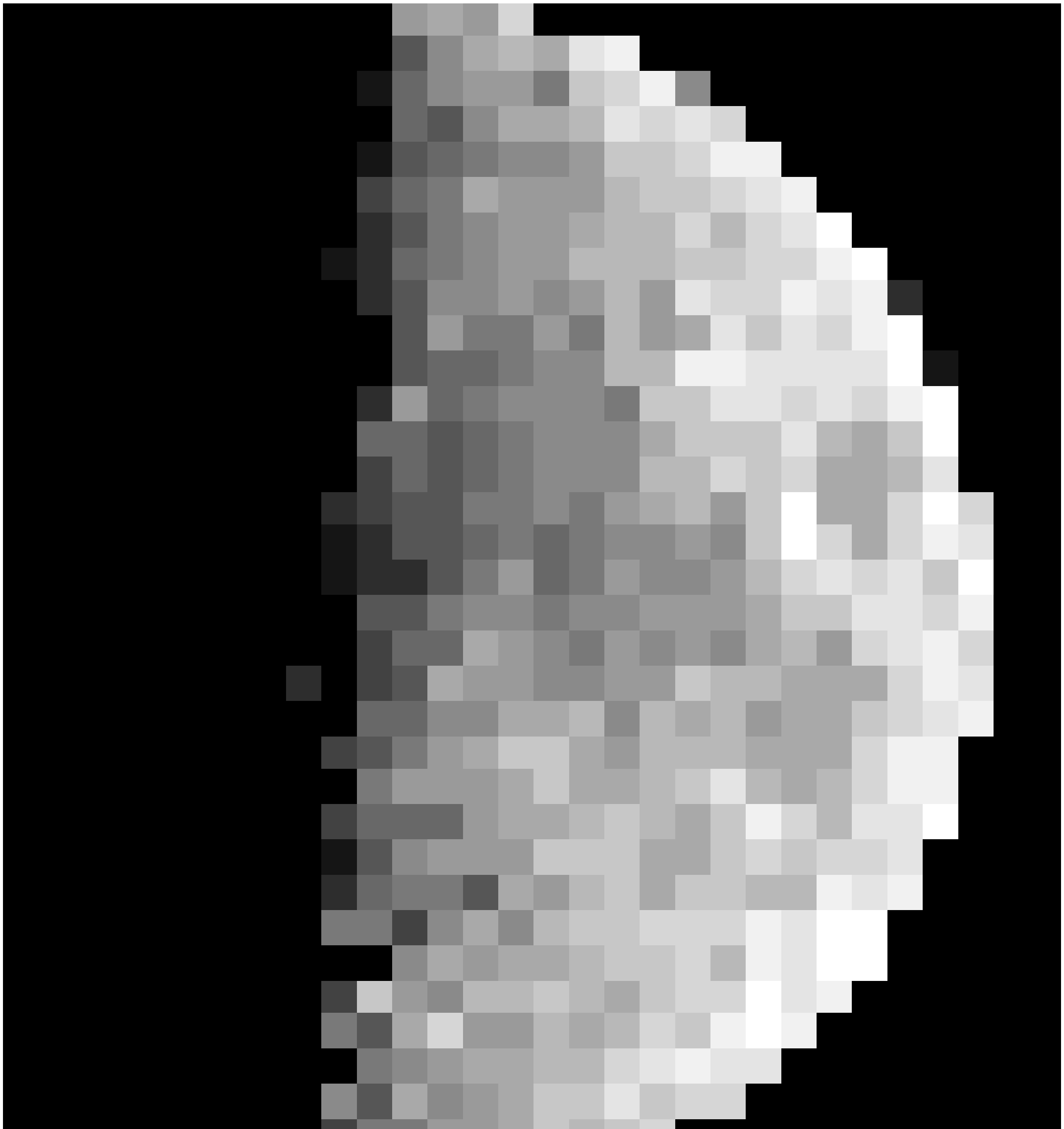


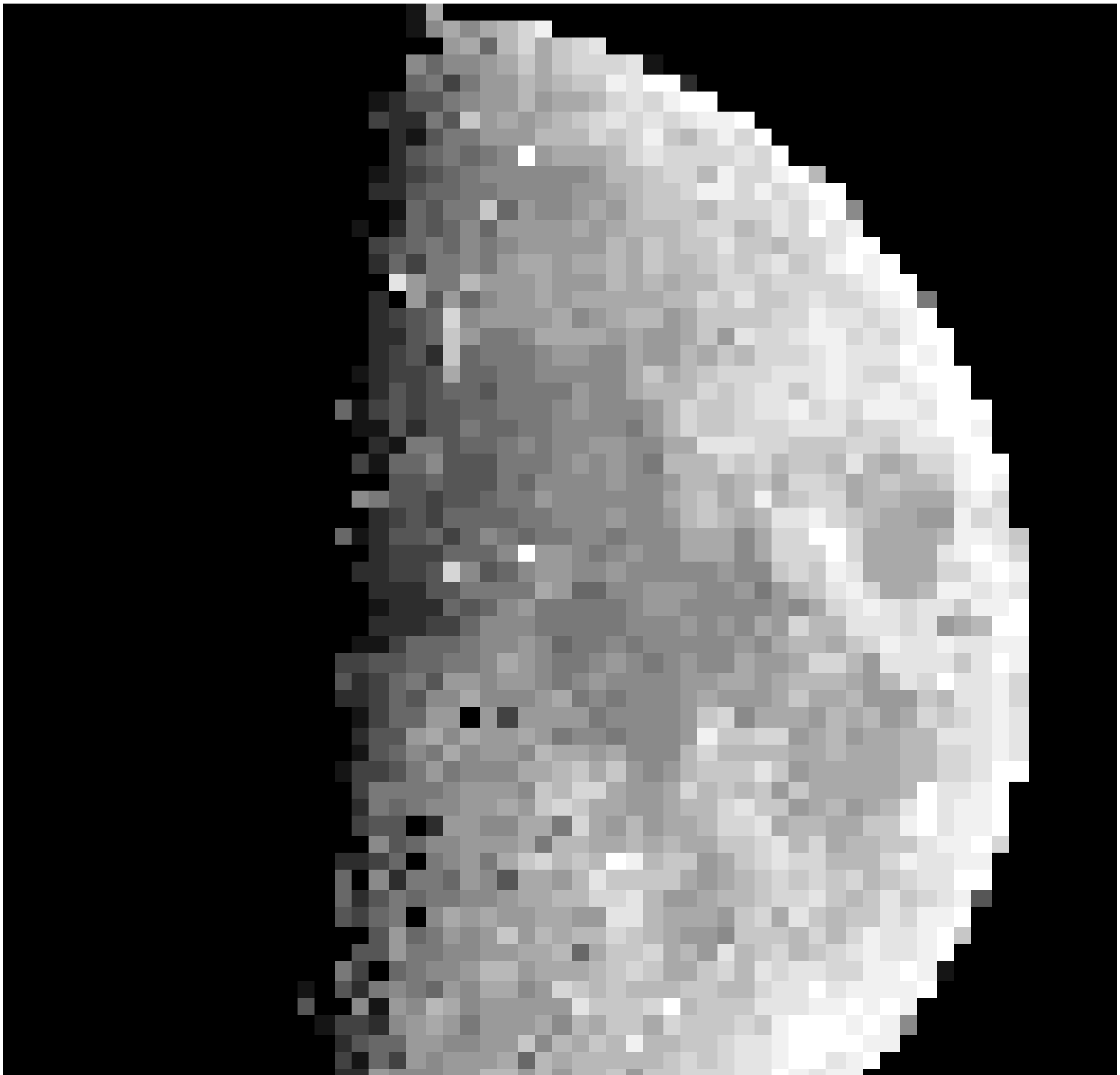


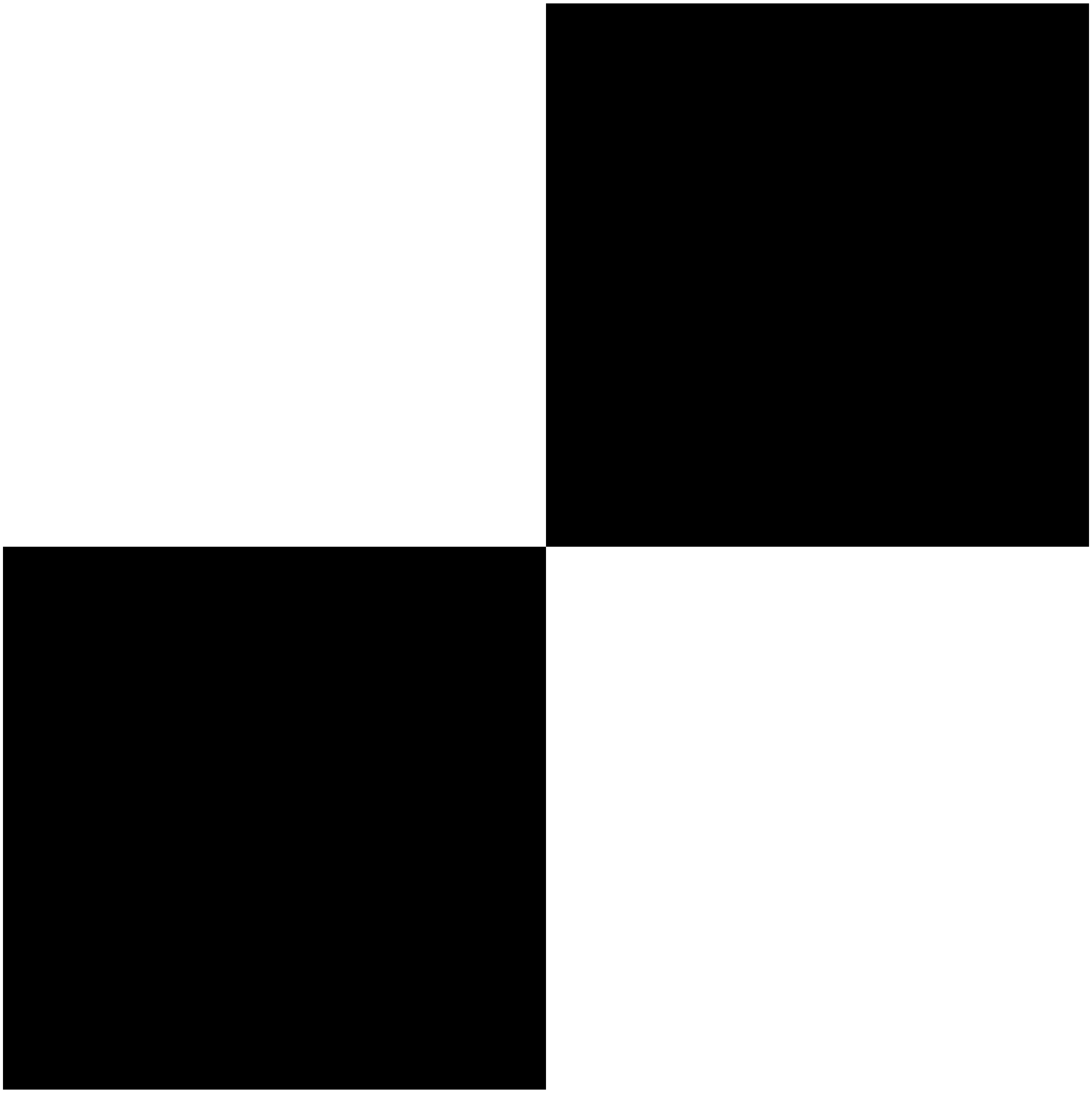


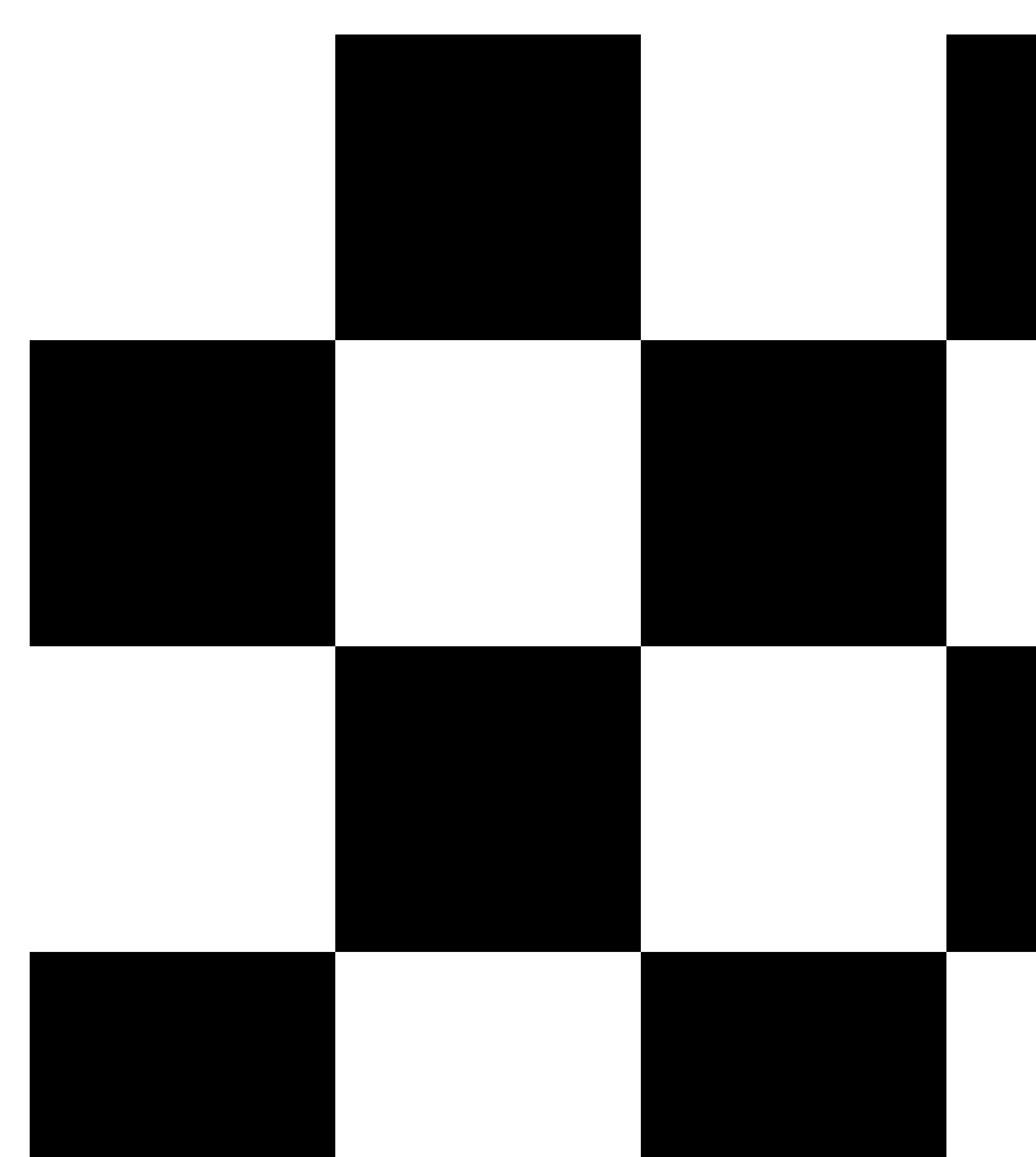


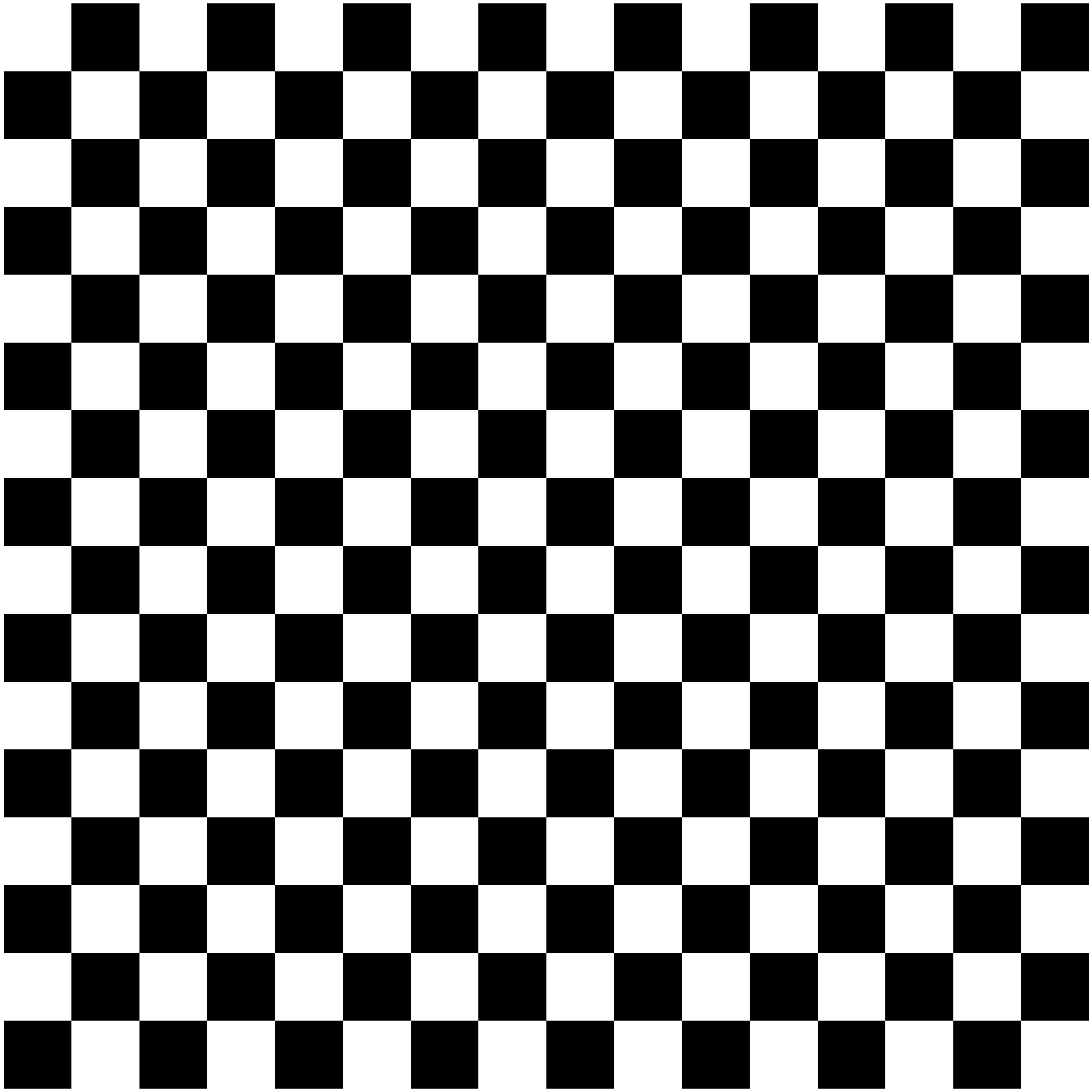


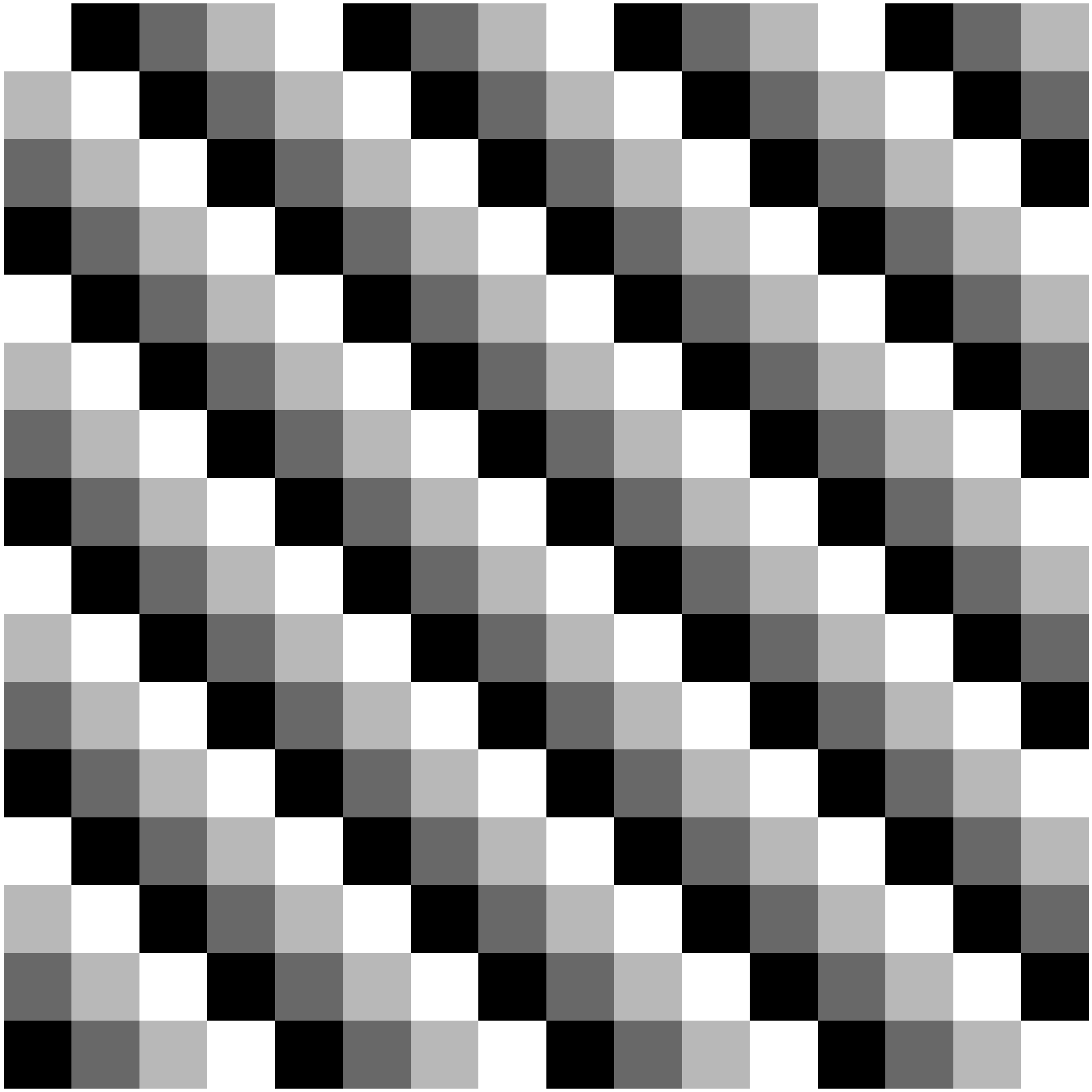


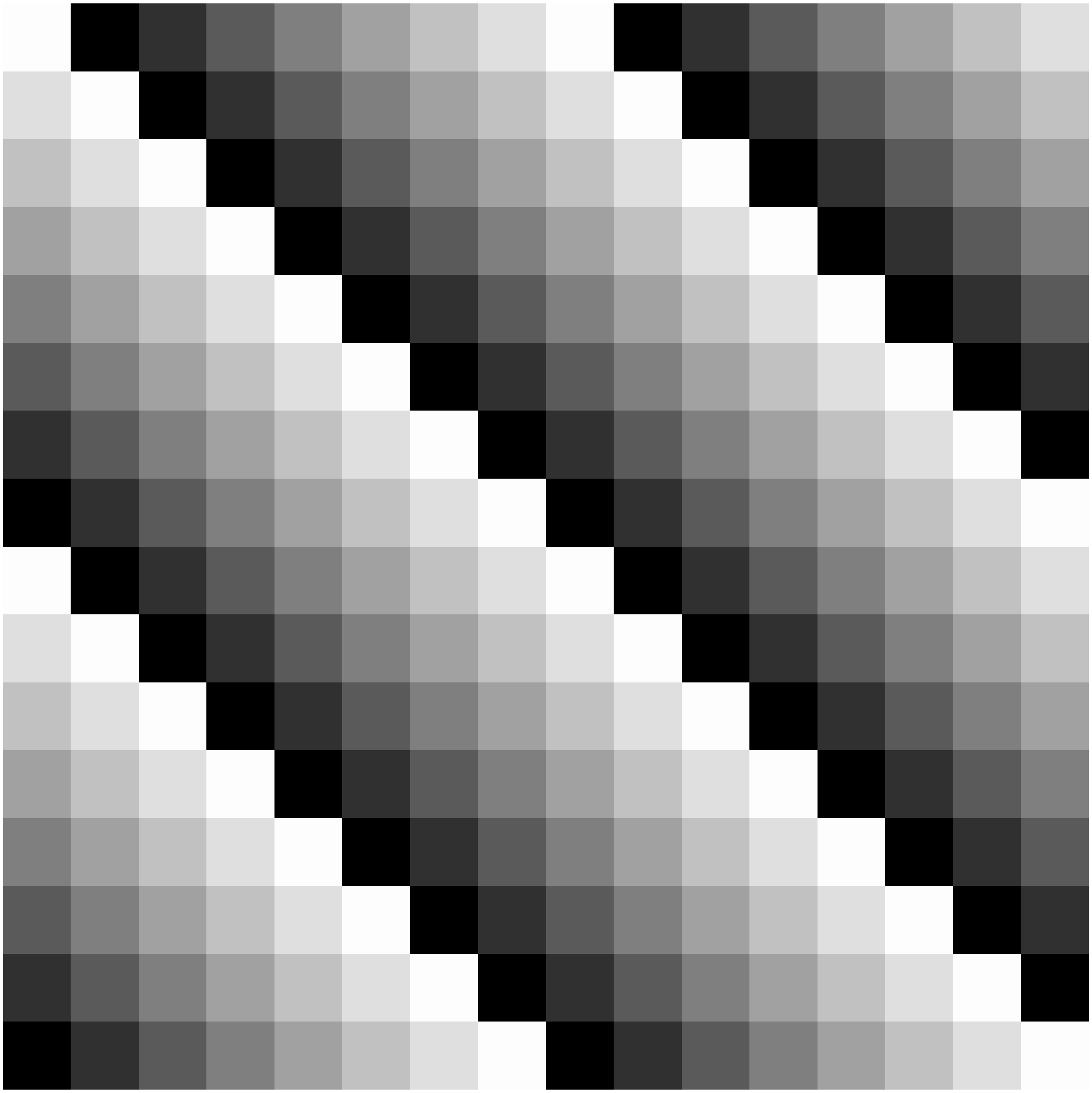


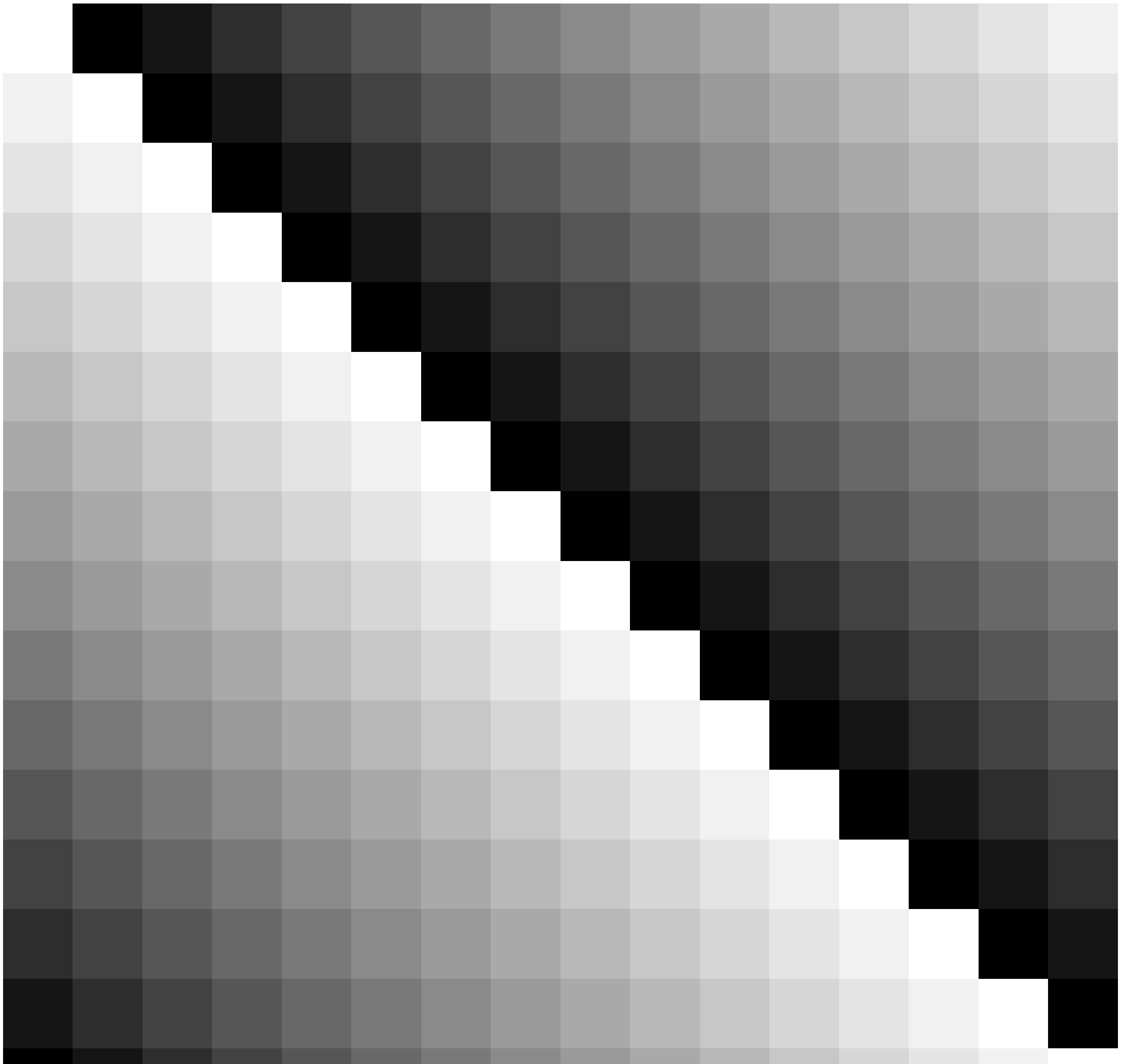


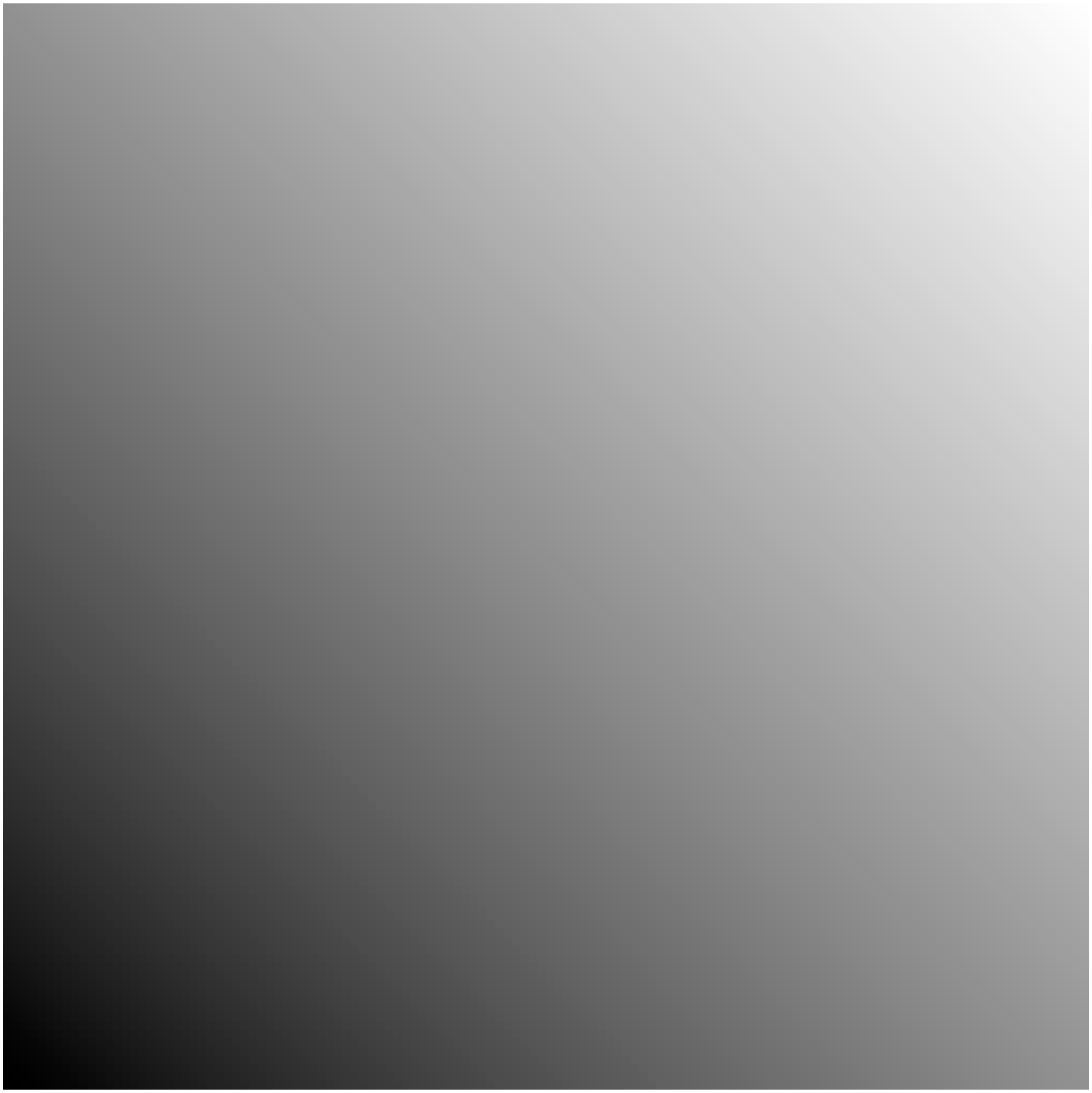


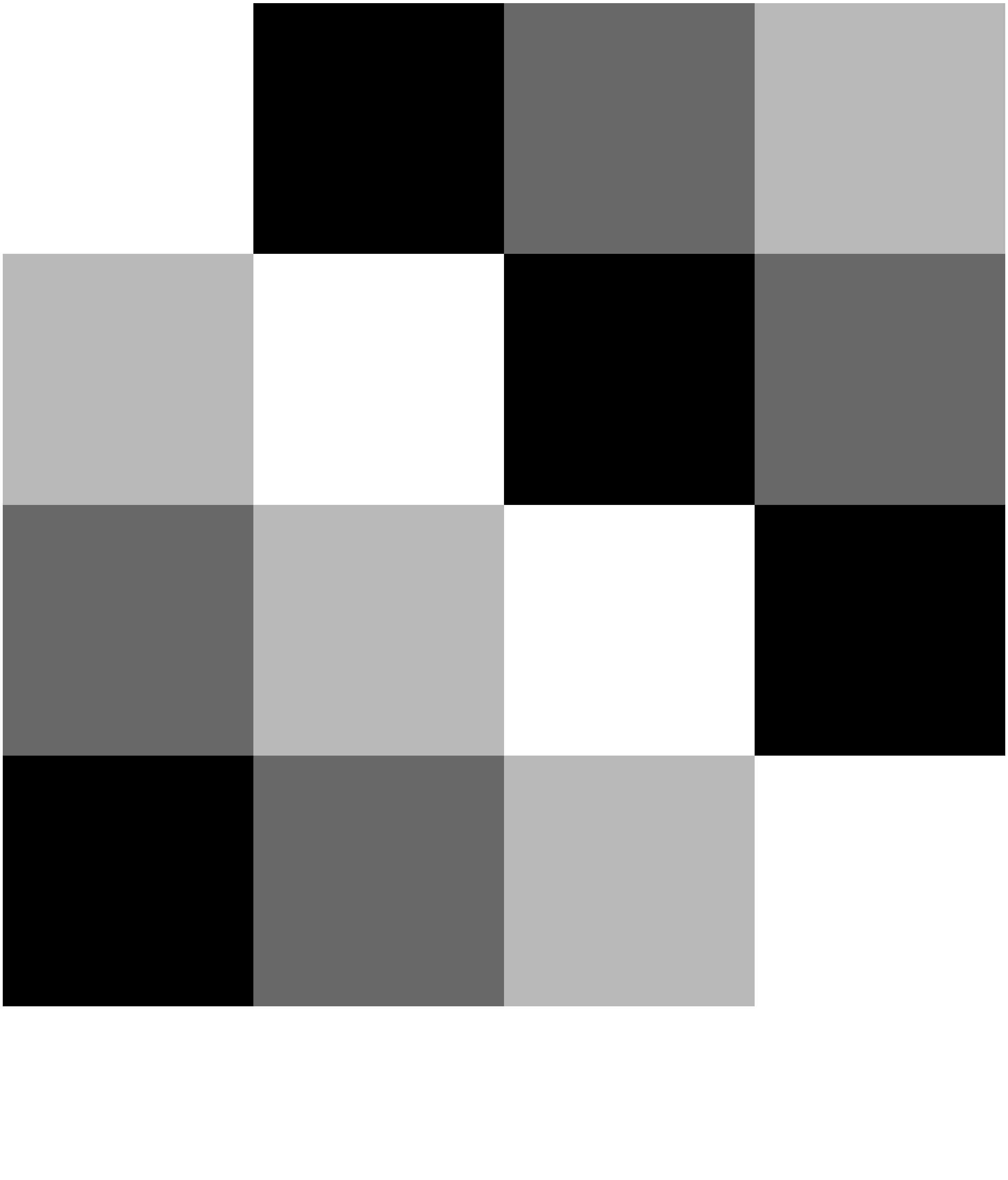


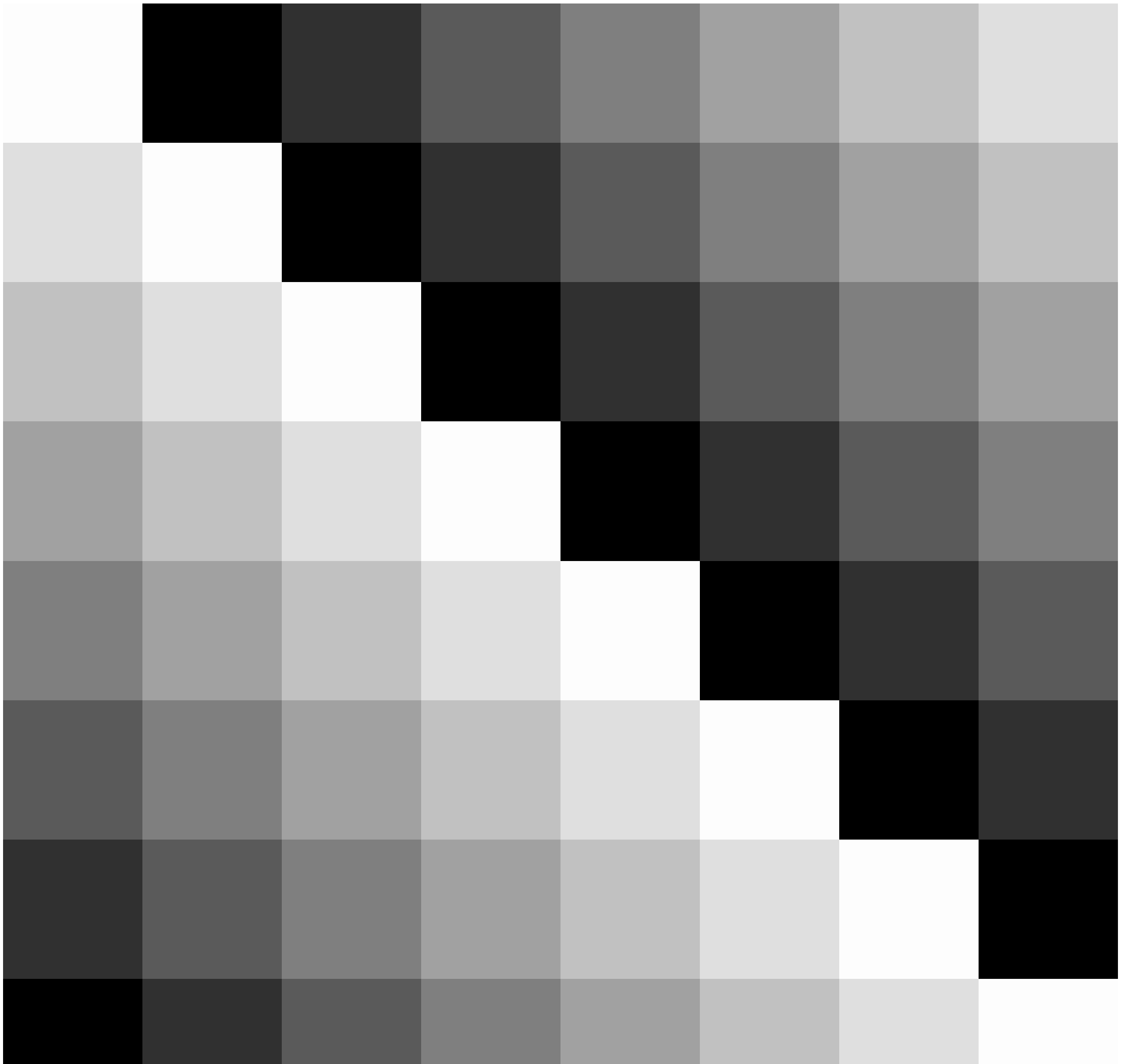


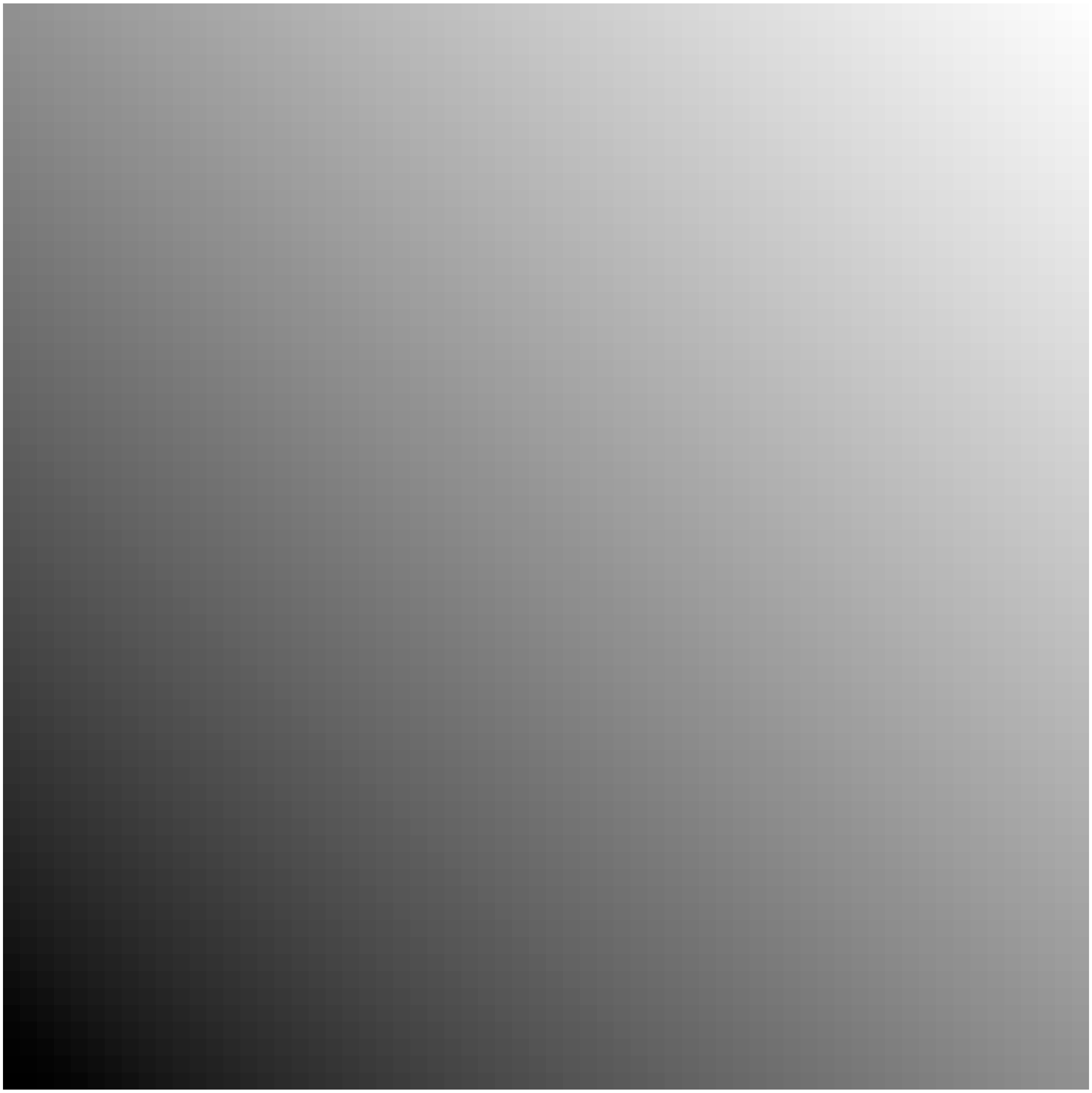


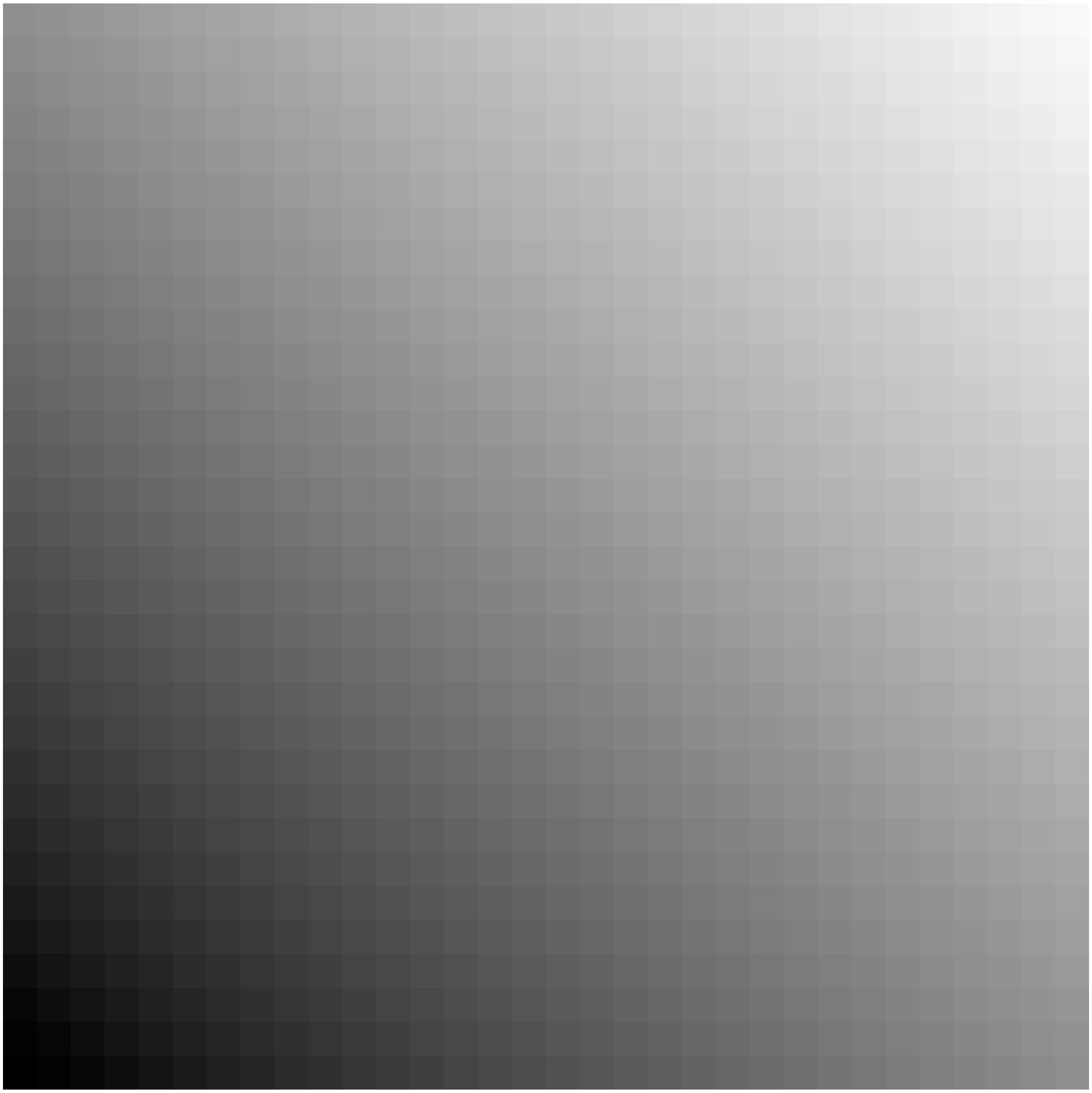


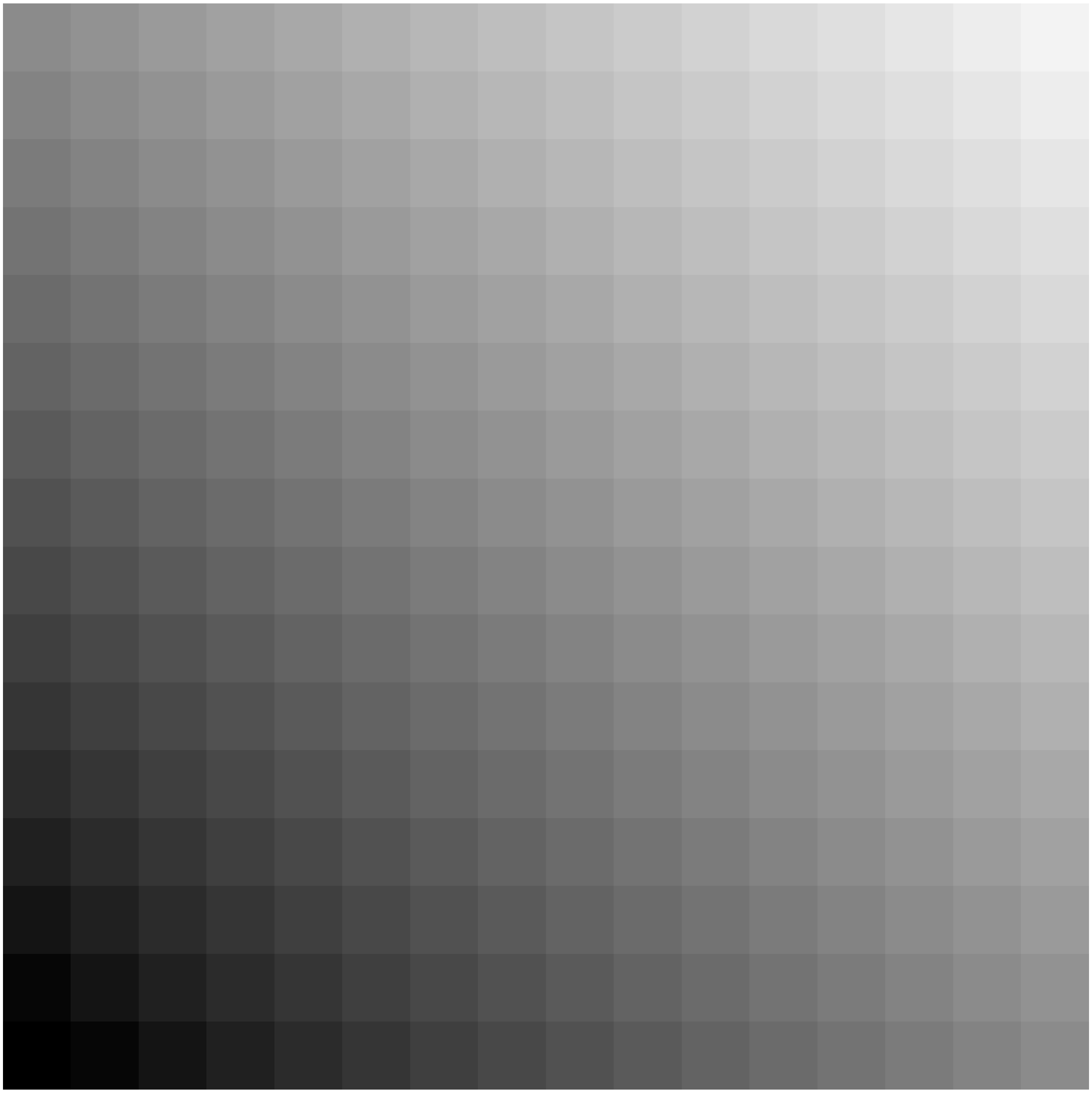


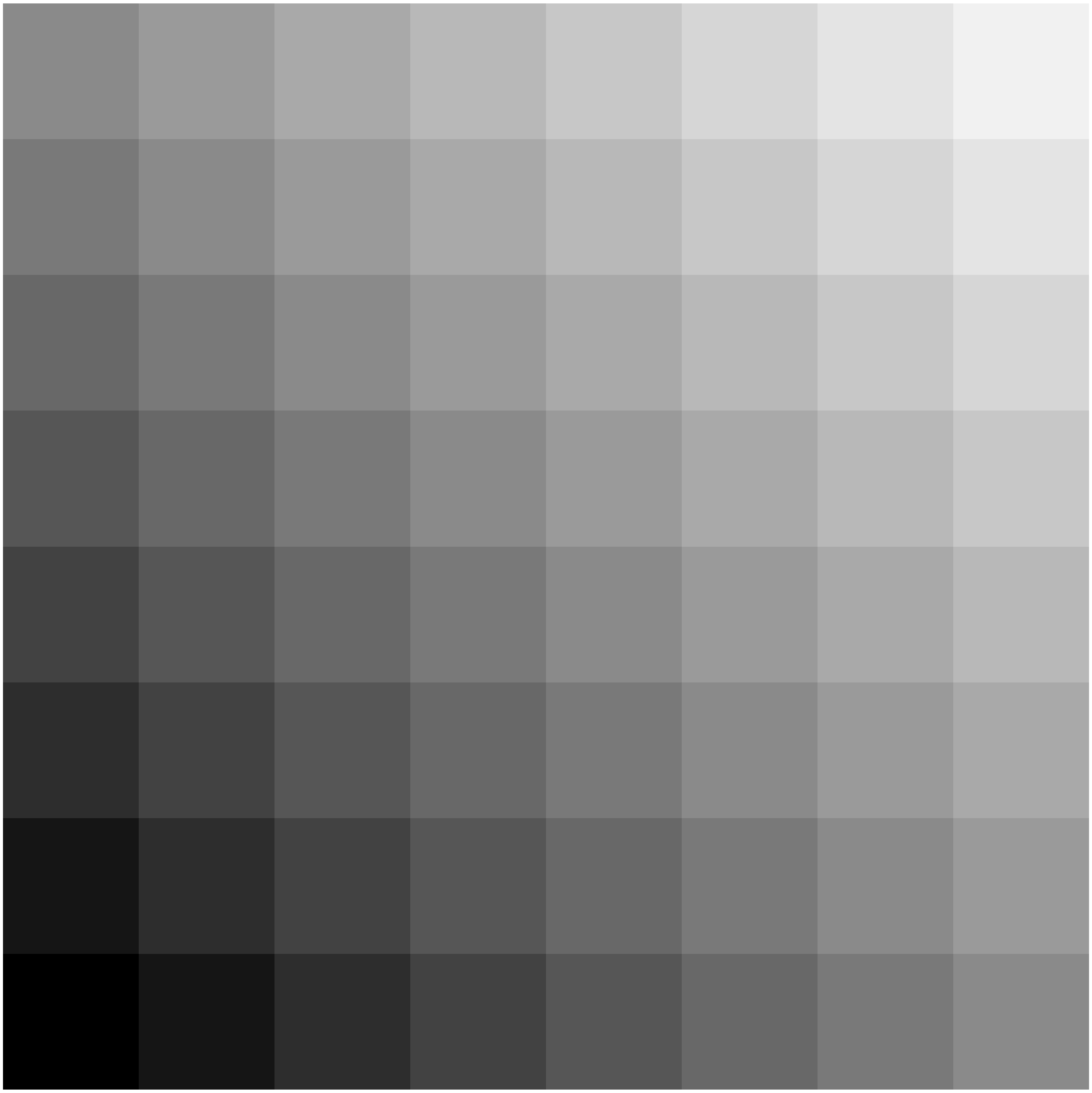


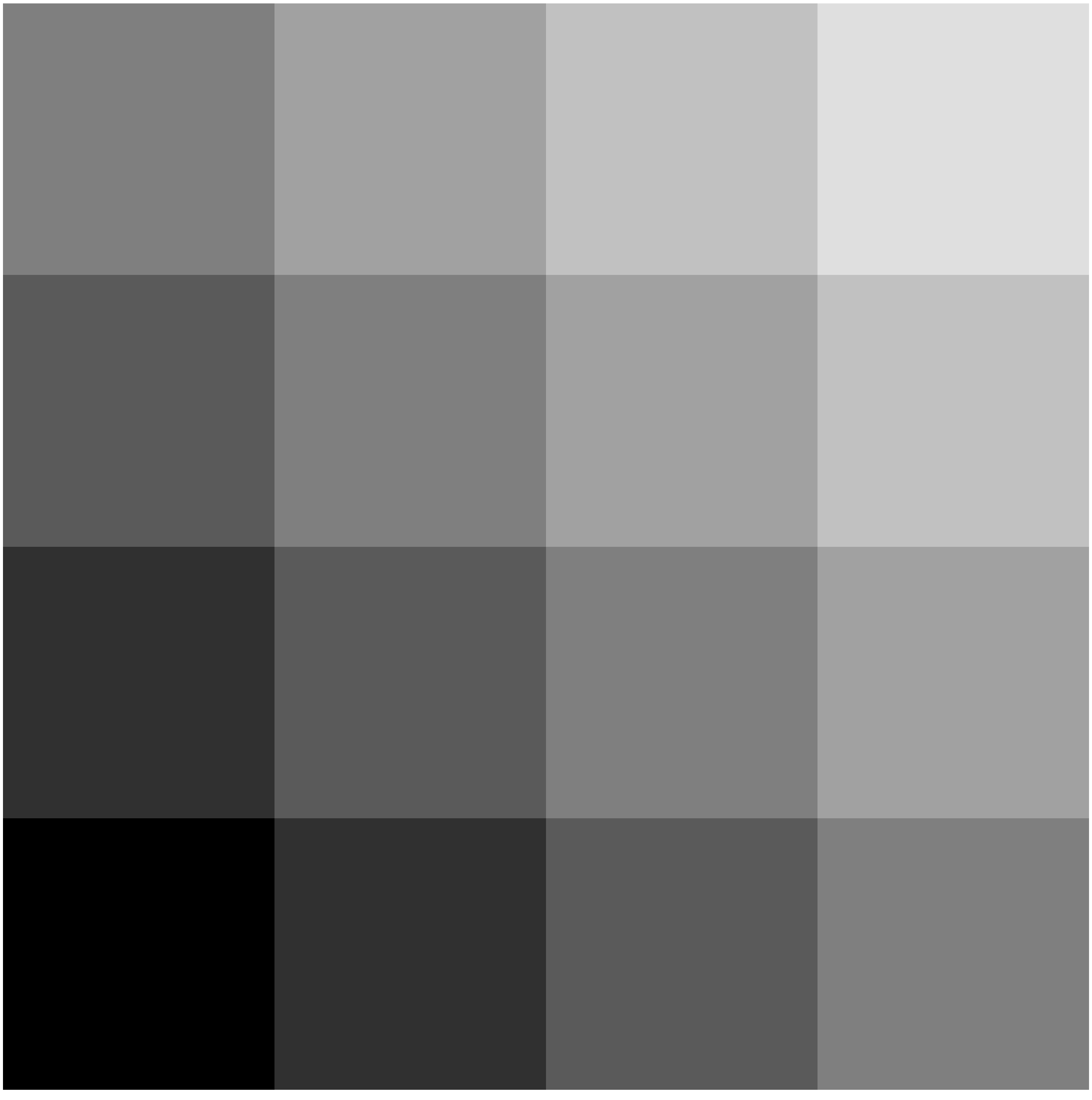


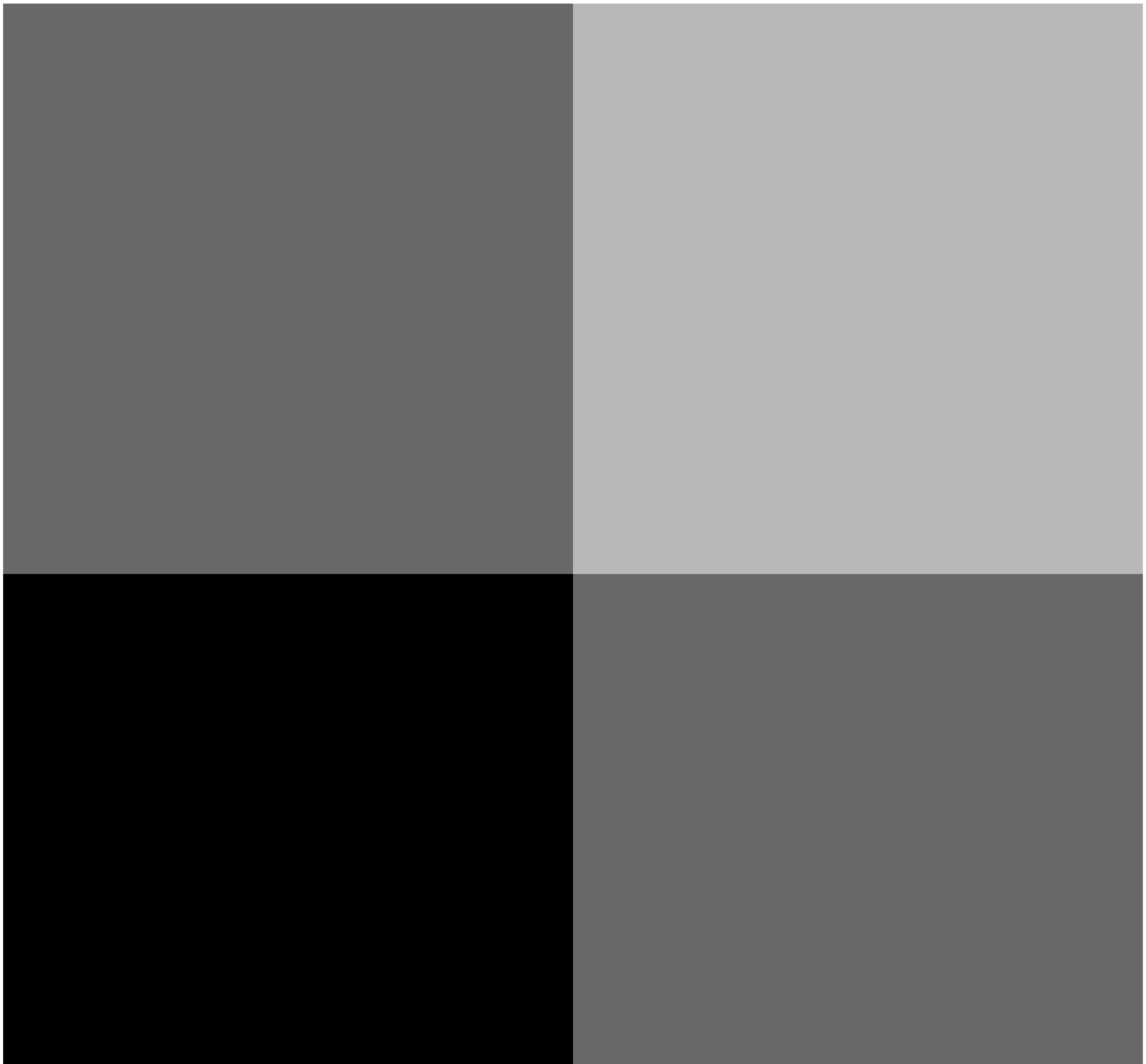




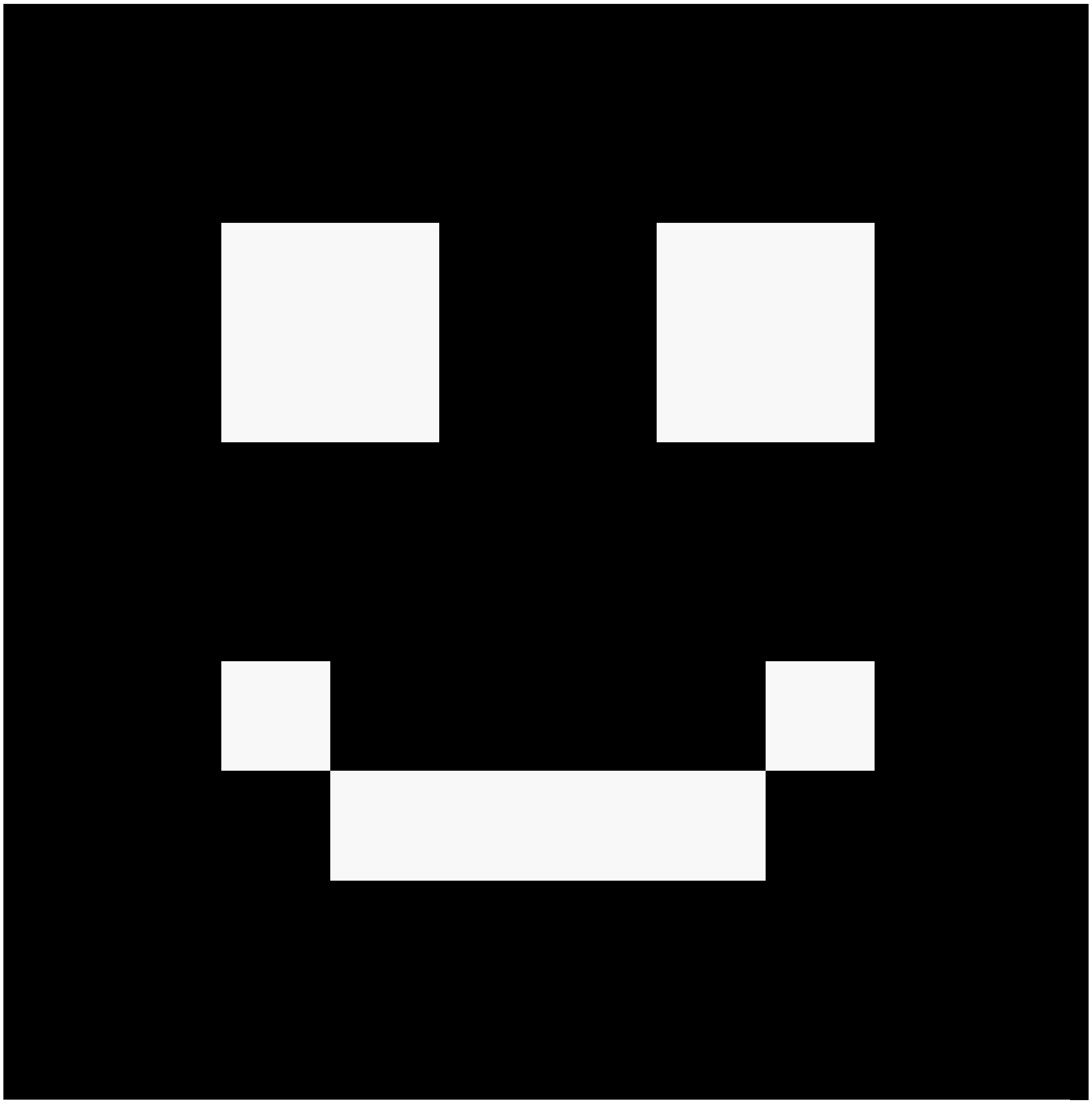








SVG: Scalable Vector Graphic



happy.svg

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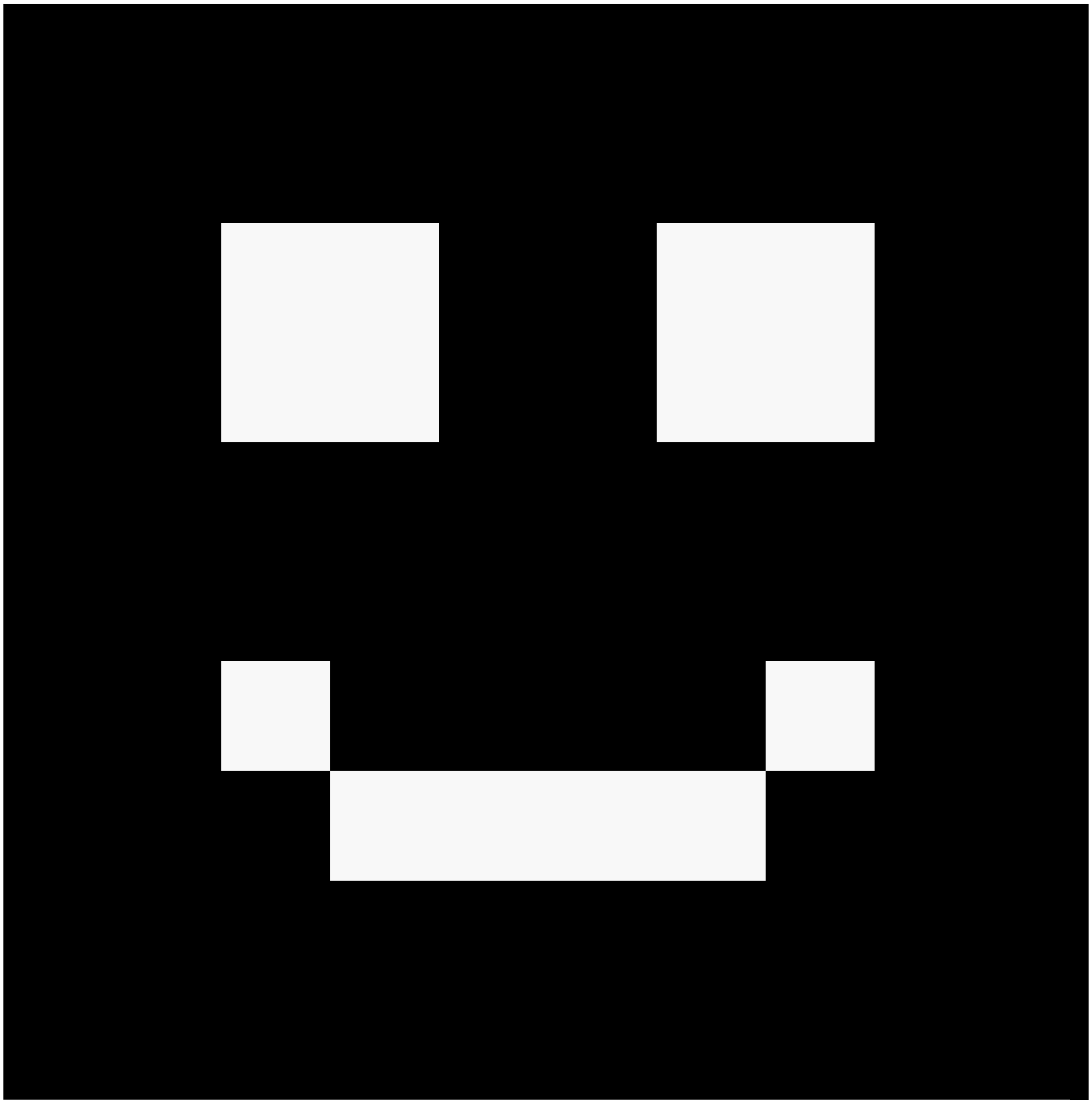
PGM: Portable Gray Map



happy.pgm

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P2
# happy.pgm
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1
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0	0	1	1	0	0	1	1	0	0
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0	0	0	1	1	1	1	0	0	0
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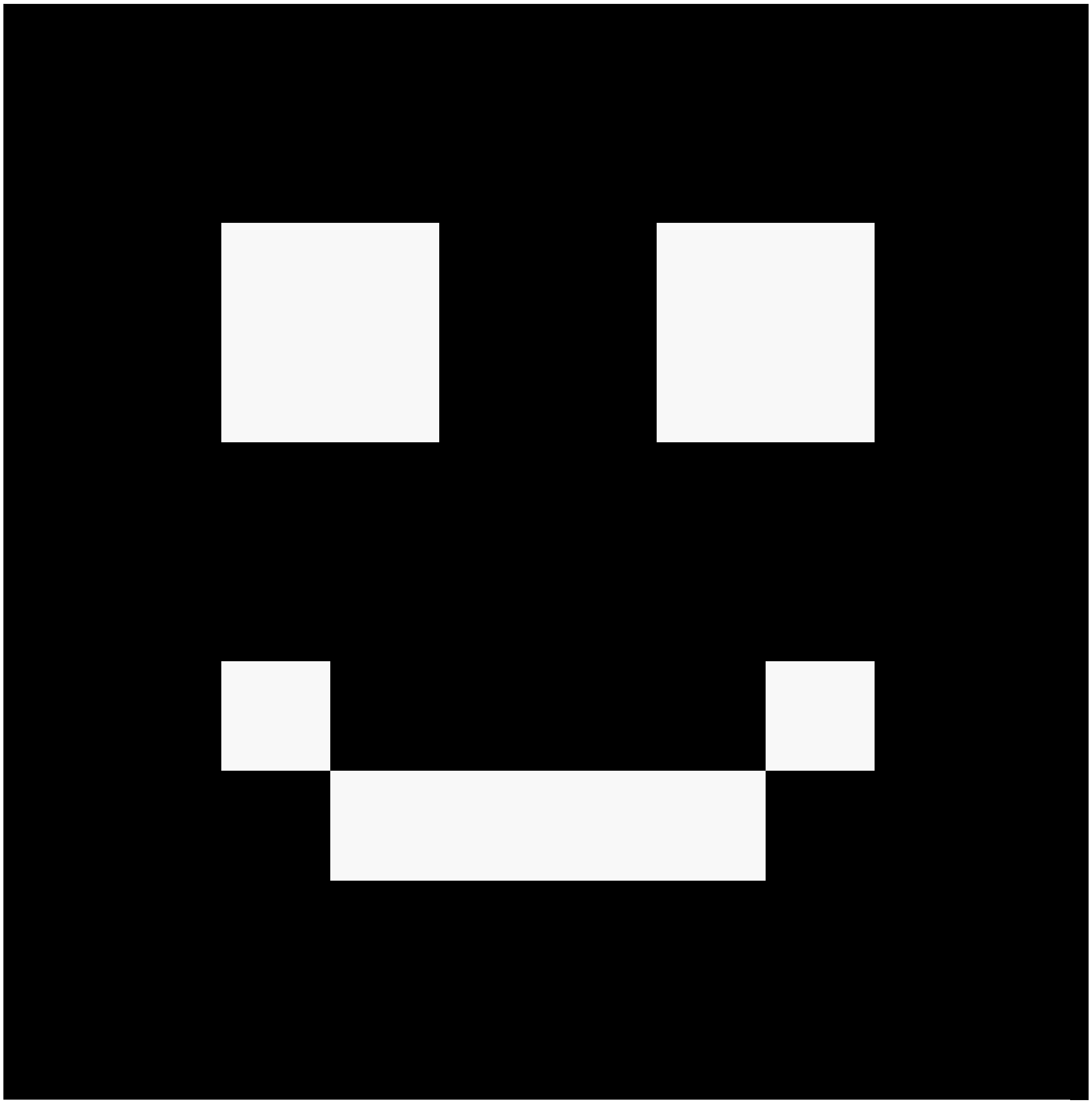
FITS: Flexible Image Transport System



happy.fits

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NAXIS1  =                   10 /
NAXIS2  =                   10 /
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EXTEND  =                    T / File May Contain Extensions
END
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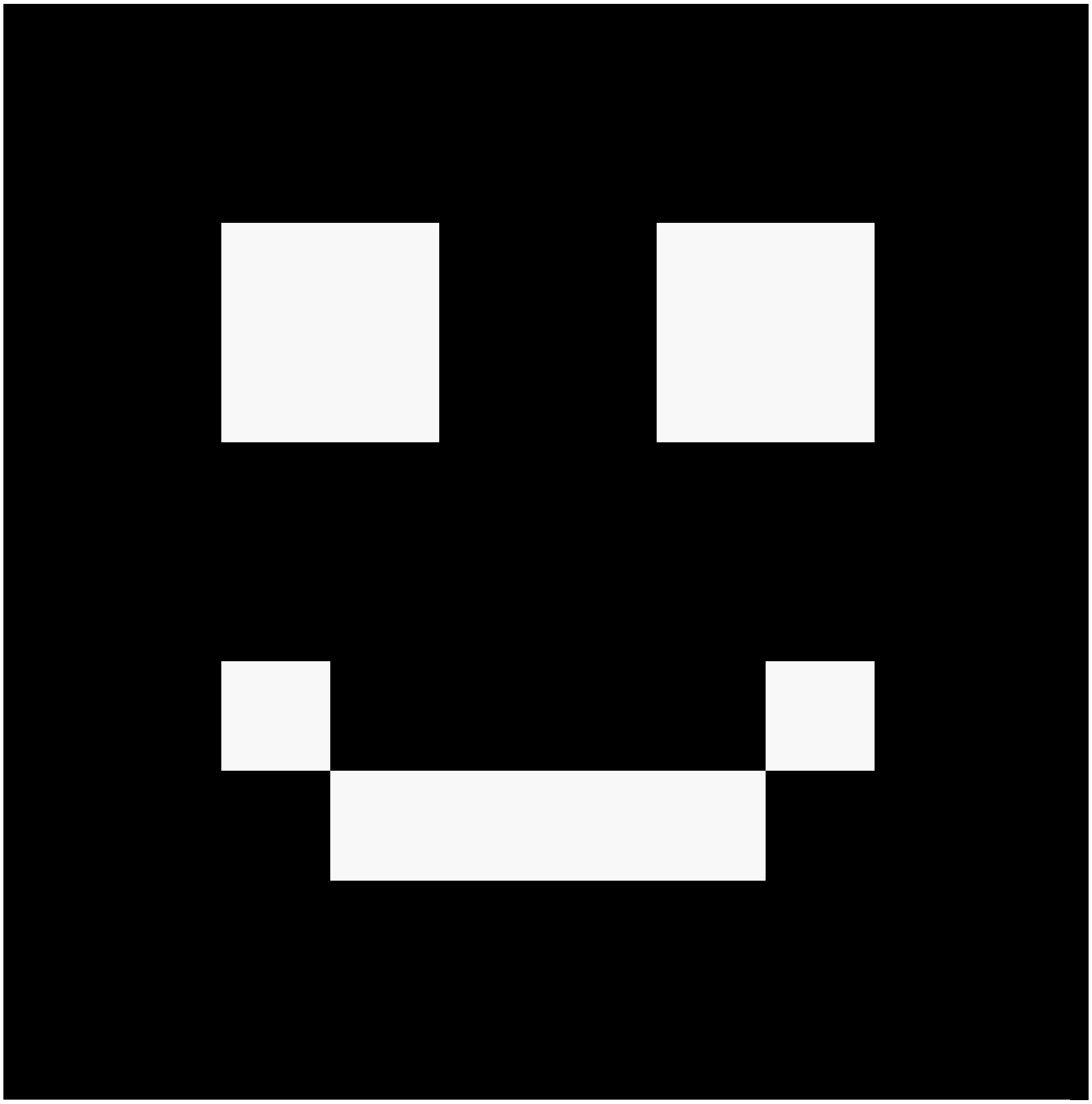
EPS: Encapsulated PostScript



happy.eps

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%%Creator: GraphicConverter V6.1.2 I386
%%Title: happy.eps
%%CreationDate: 2008-08-08
%%Pages: 1
%%BoundingBox: 0 0 10 10
%%DocumentData: Clean7Bit
%%EndComments
%%BeginProlog
%%EndProlog
%%Page: 1 1
%ImageData: 10 10 8 1 0 10 2 } exec
/languagelevel where {pop languagelevel 2 lt} {true} ifelse {
 (JPEG picture requires Postscript level 2
) dup print flush
 /Helvetica findfont 20 scalefont setfont 100 100 moveto show
showpage stop } if
save /RawData currentfile /ASCIIHexDecode filter def
/Data RawData << >> /DCTDecode filter def
10.00 10.00 scale
/DeviceGray setcolorspace
{ << /ImageType 1
     /Width 10
     /Height 10
    /ImageMatrix [ 10 0 0 -10 0 10 ]
    /DataSource Data
    /BitsPerComponent 8
     /Decode [0 1]
>> image
 Data closefile
 RawData flushfile
 showpage
 restore
} exec
FFD8FFE000104A46494600010101004800480000FFFE000C4170706C654D61
726B0AFFDB004300070505060505070606060807070808A110B0A09090A140F
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000102030405060708090A0B100002010303020403050504040000017D0102
03000411051221314106135161072271143281 91A1082342B1C11552D1F024
33627282090A161718191A25262728292A3435363738393A434445464748 49
4A535455565758595A636465666768696A737475767778797A838485868788
898A92939495969798999AA2A3A4A5A6A7A8A9AAB2B3B4B5B6B7B8B9BAC2C3
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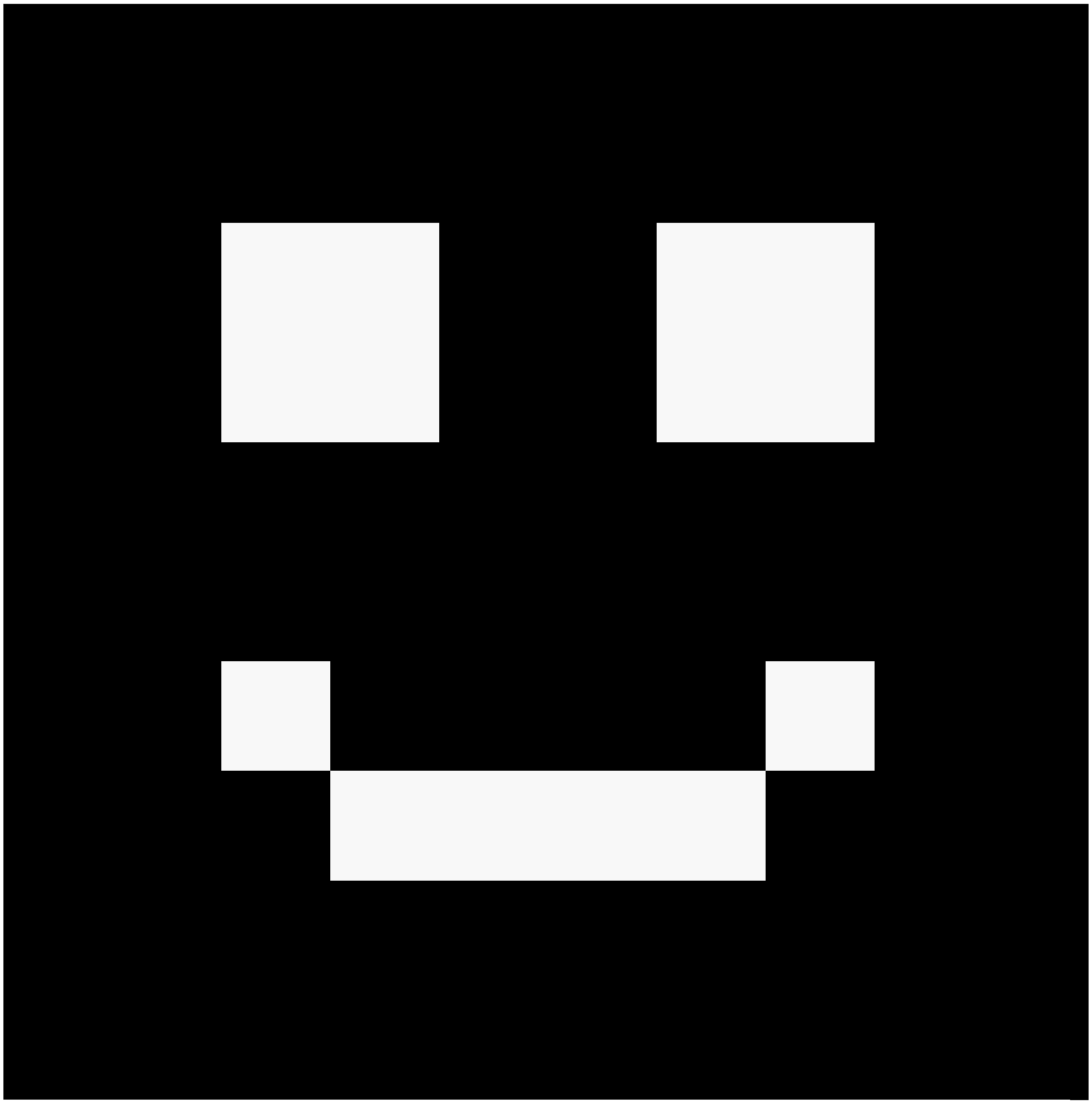
%%EOF
```

PNG: Portable Network Graphic



happy.png

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080808DBE14FE000000300504C5445000000000000000000000000000000000000000000000000
00000000000000000000000000000000000000000000000000000000000000000000000000000000
00000000000000000000000000000000000000000000000000000000000000000000000000000000
00000000000000000000000000000000000000000000000001000001000001000001000001000001
00000100000100000100000100000300000300000500000500000800000C00001300001300001300
00130000130000130000130000130000130000130000130000130000130000130000130000130000
13000013000013000013000013000013000013000013000013000013000013000013000013000013
00001300001300001300001300001300001300001300021300021300021300001B00001C00001C00
20000020000020000020000020030000028000300020130020130020130000350001340041000000
440044000001480000 4F00004F00004F00004F00004F00004F00004F00004F00004F00004F00004F
00004F00004F00004F00004F00004F00004F00004F00004F00004F00004F00004F00004F00004F00
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E00000E40000E83F00AC0044A8800071800071800071 0000F43F209800D82080007880007880007 8
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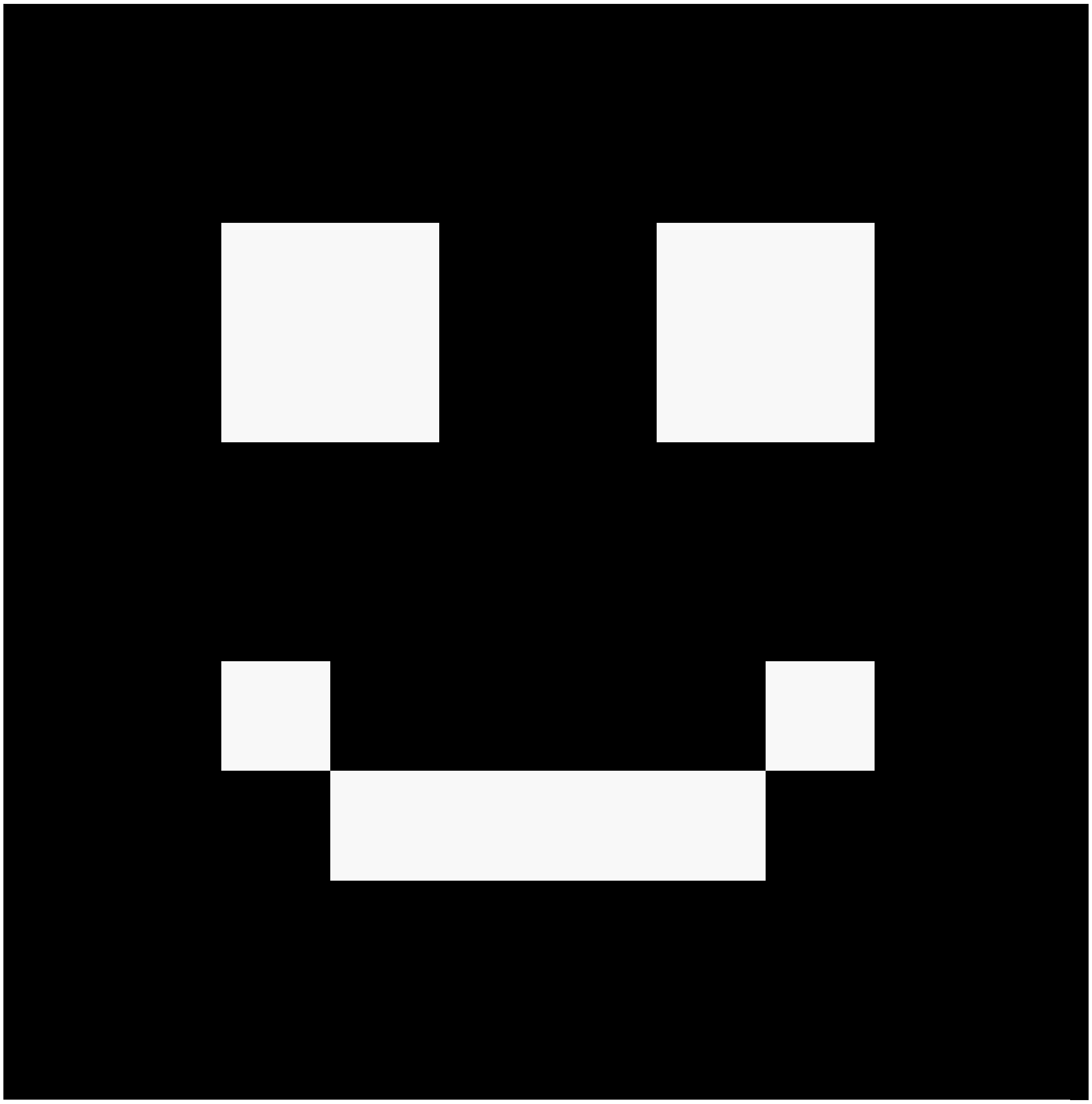
40940E44E940940E44E940940E44E940940E44E940940E44E940940E44E940940E44E940940E44E9

JPEG/JPG: Joint Photographic Experts Group



happy.jpg

FFD8FFE00010 JFIF 0001010100480048000OFFFE000C2 happy.pgm
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FFC0000B08000A000A01011100FFC4001F0000010501010101010100000000000000
0001020304050607080 90A0BFFC400B5100002010303020403050504040000017D0102
030004110512213141061351610722711432819 1A1082342B1C11552D1F0243362728
2090A161718191A25262728292A3435363738393A434445464748494A535455565758
595A636465666768696A737475767778797A838485868788898A9293949596979899 9
AA2A3A4A5A6A7A8A9AAB2B3B4B5B6B7B8B9BAC2C3C4C5C6C7C8C9CAD2D3D4D5D6D7D8
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137816CF5DD0BE1A6BA3F677D43C73E1FD2FF00B4FF00E129D6AD3C47710586ABBD9D
6DFED97280C5A47D900591BCC64DD1EC964DB1C8AE7E6BA28AFFD9

Digital Images Homework

Due in class Thursday, October 23

This morning you and your team were given a set of budgetary constraints and instructed to make measurements of an image and turn those measurements into a set of data, subject to the given restrictions. During the course of this exercise your team chose between various trade-offs – for example, in the level of detail you captured and in the number of colors or grayscale levels you would use to represent your image. Your homework consists of two parts:

1) As a group, decide how you will encode your measurements into an image file format. You may either create your own file format or use one of the (human-readable) formats discussed in class. The printed “image file” should include all information necessary for a human to properly decode the file and reconstruct the image. **Each member of your group will turn in a copy of this written file.**
2) Individually and on separate paper, include a written description of your team's image encoding process and choices, an explanation of the reasons for those choices, and the final “cost” of your image based on the initial constraints. The description can be in a professional format of your choosing; for example, it could take the form of a memorandum documenting an engineering decision or of persuasive correspondence to a potential customer. Each member of a team should write this document separately.

In class on Thursday you will exchange your written “image file” with another group and then decode and create a copy of their file.

If you have questions you can ask your teammates, your fellow students, or your instructors. In addition, the visiting instructors (Katie, Chris, and Ian) will hold office hours on Wednesday from 1:00 PM to 3:00 PM in room 210 Ka'aike.

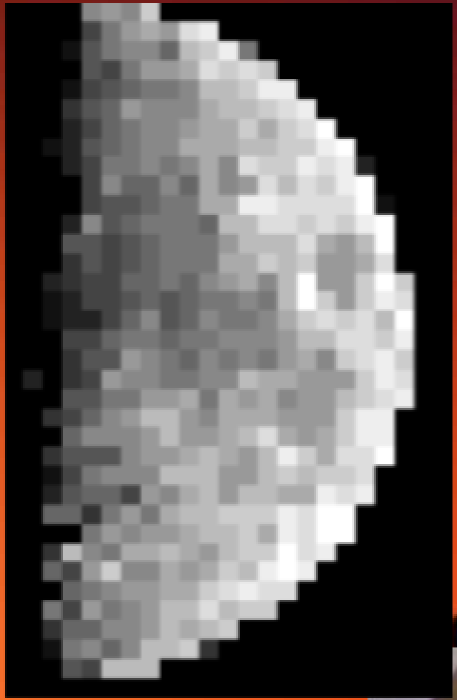
Digital Image Files: Day 2

Katie Morzinski, Ian Crossfield, and Chris Crockett, guest teachers

21-23 Oct. 2008

The starters got us to think about the different issues involved in recording or sending images

- Transmitting images
- Spatial information
- Color/grayscale information
- Image file formats
- Measuring light levels with a photometer



We designed our own astronomical camera and image file format

- "Our own camera" -- we designed a way to record an image
- We were given an image, a scientific goal, and budgetary constraits
- We had to communicate our image in writing--we designed an image file format

We encoded an image--Now it's time to decode another team's image

- Does the other team understand your image file?
- Do you understand the other team's image file?
- How do you make a picture from numbers or directions?
- How do you assign colors or grayscale to numbers?

Today we wrap up with sharing and then a computer investigation

- Schedule:
- Day 2:
- Investigation 2--Image decoding (30 min.)
- Prep for sharing (15 min.)
- Sharing (30 min.)
- Investigation 3--Computer image manipulation (30 min.)
- Synthesis (20 min.)
- Homework

Decoding Digital Images

Is this process straightforward?

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	1	1	0	0	1	1	0	0
0	0	1	1	0	0	1	1	0	0
0	0	0	0	0	0	0	0	0	0
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0	0	1	0	0	0	0	1	0	0
0	0	0	1	1	1	1	0	0	0
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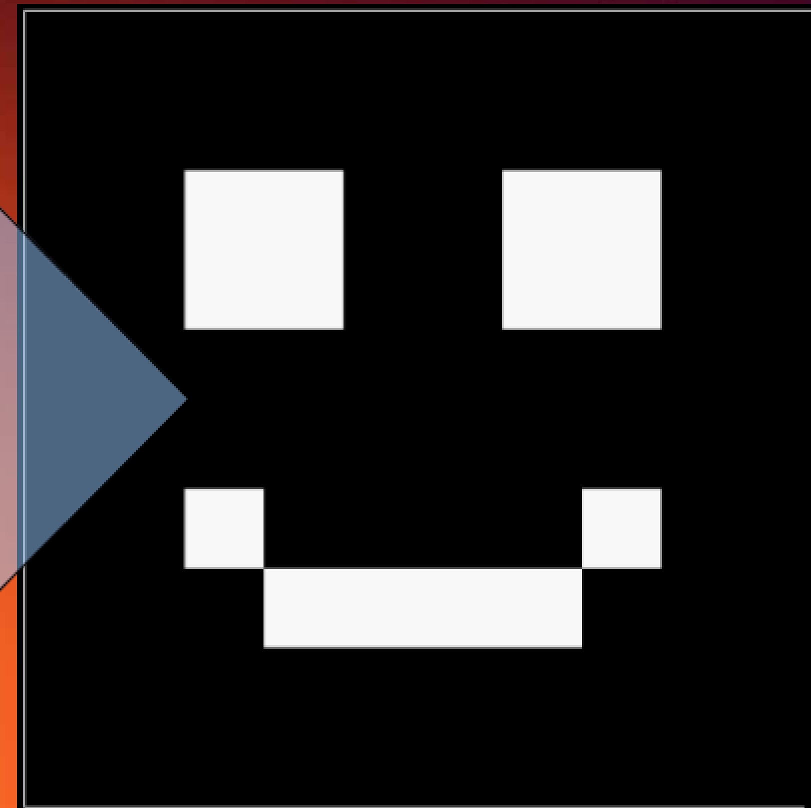
0	0	0	0	0	0	0	0	0	0



Decoding Digital Images

- First image from Mars, sent by Mariner 4
- NASA engineers colored-by-number and beat the officially released image

Image credit: JPL/NASA

“Real-time data translator”

Decoding Digital Images

- This morning you will all be "real-time data translators"
- Your goal is to accurately translate and recreate an image file sent by another team
- You have thirty minutes; good luck!

The MCC Image File Format

The first line consists of two numbers which define the number of rows and columns.

The second line consists of two numbers which define the brightness scale. The first number corresponds to black and the second number corresponds to white.

The remaining numbers define the pixel values of the image, arranged in a grid. The first number in the grid corresponds to the upper left pixel of the image.

12	12										
0	12										
0	0	0	0	4	8	10	8	11	12	0	0
0	0	2	6	7	6	6	5	9	7	6	0
0	1	3	3	2	4	7	6	7	7	6	9
0	1	2	2	3	4	7	4	7	9	8	7
0	2	2	3	3	6	2	3	4	7	4	6
0	2	3	5	6	4	8	4	2	1	7	7
0	2	3	7	4	6	9	3	2	2	2	4
0	3	3	5	5	9	8	11	4	7	2	6
0	8	2	3	3	9	9	9	7	9	5	5
0	0	5	7	4	10	10	9	9	10	6	0
0	0	0	5	10	10	9	9	8	6	0	0
0	0	0	0	0	0	7	0	0	0	0	0

The MCC Image File Format

The first line consists of two numbers which define the number of rows and columns.

The second line consists of two numbers which define the brightness scale. The first number corresponds to black and the second number corresponds to white.

The remaining numbers define the pixel values of the image, arranged in a grid. The first number in the grid corresponds to the upper left pixel of the image.

12	12										
0	11										
0	0	0	0	0	0	3	3	2	0	0	0
0	0	0	0	6	6	5	4	3	1	0	0
0	0	0	8	8	8	6	5	3	2	0	0
0	0	9	10	10	9	6	5	4	2	0	0
0	0	8	7	7	7	6	5	3	2	0	0
0	0	10	11	10	8	7	6	4	2	1	0
0	0	8	9	9	7	6	6	4	2	0	0
0	0	9	9	7	8	6	5	4	2	0	0
0	0	0	8	7	7	6	5	3	2	0	0
0	0	0	0	7	6	5	4	2	1	0	0
0	0	0	0	0	0	4	3	2	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0

The MCC Image File Format

The first line consists of two numbers which define the number of rows and columns.

The second line consists of two numbers which define the brightness scale. The first number corresponds to black and the second number corresponds to white.

The remaining numbers define the pixel values of the image, arranged in a grid. The first number in the grid corresponds to the upper left pixel of the image.

12 12
0 8

0	0	0	0	0	0	4	0	0	0	0	0
0	0	0	3	2	1	1	0	1	5	0	0
0	0	4	2	3	4	0	0	3	0	4	0
0	0	1	4	7	2	0	0	0	3	1	0
0	4	1	1	6	1	0	0	0	0	0	0
0	3	1	1	0	1	0	0	0	0	0	0
0	4	1	1	8	1	0	0	0	0	0	0
0	0	1	2	1	4	0	0	0	0	0	0
0	0	2	0	0	1	1	1	0	0	3	0
0	0	0	2	0	0	0	0	0	2	0	0
0	0	0	0	0	3	2	4	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0

The MCC Image File Format

The first line consists of two numbers which define the number of rows and columns.

The second line consists of two numbers which define the brightness scale. The first number corresponds to black and the second number corresponds to white.

The remaining numbers define the pixel values of the image, arranged in a grid. The first number in the grid corresponds to the upper left pixel of the image.

12 12
0 10

6	7	5	7	1	3	5	4	10	5	7	6
4	6	0	7	3	4	1	6	4	5	9	5
4	1	3	0	0	2	5	2	5	3	4	3
4	5	2	4	0	0	2	1	3	2	6	3
4	8	3	3	2	1	5	2	2	4	5	2
9	8	4	5	7	7	2	3	2	3	6	8
7	7	5	10	4	3	3	2	2	4	1	5
4	5	5	6	6	3	9	2	0	0	1	3
5	6	3	3	4	7	4	2	0	0	2	3
8	6	5	1	1	3	7	6	5	6	7	4
5	6	6	8	2	1	7	6	3	2	5	7
5	4	5	4	4	8	5	4	4	4	7	6

Rubric for Jigsaw Sharing, "Digital Image Files"

Name: ___________________________________

Total Score:
1—Did not meet expectations
2—Met Expectations
3—Exceeded expectations

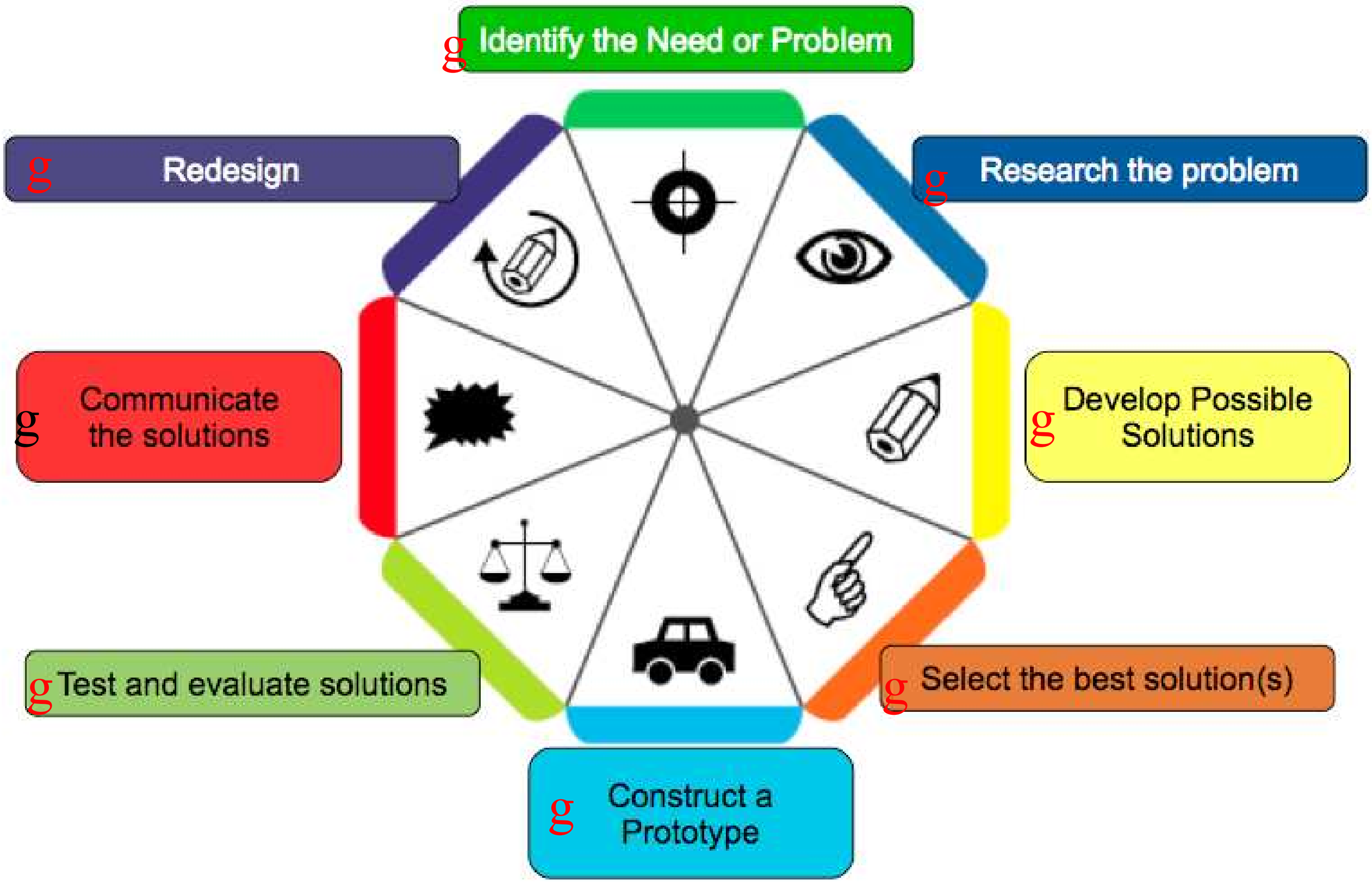
Task	+1	+1	+1	Score
Describe team's image encoding process and choices.	Student shows their original image, the drawing another team made of it, and explains the scientific goal they were working toward.	Student describes their image encoding method (photometer digitization, vector graphics, or other).	Student explains the trade-offs they evaluated and gives reasons for choosing their image encoding method.	
Describe team's image file format, giving reasons.	Student shows their image file format, identifying the header and body.	Student explains what the header and body mean, and why the particular image file format was chosen to meet the scientific goals.	Student evaluates the clarity of their image file format by the fidelity of the drawn image, and suggests changes they could have made to clarify their image encoding.	
Demonstrate communication skills.	Student speaks and has visual aids.	Student speaks clearly and audibly, and has visual aids that are legible and appropriate.	Student engages in relevant discussion with classmates about presentation.	

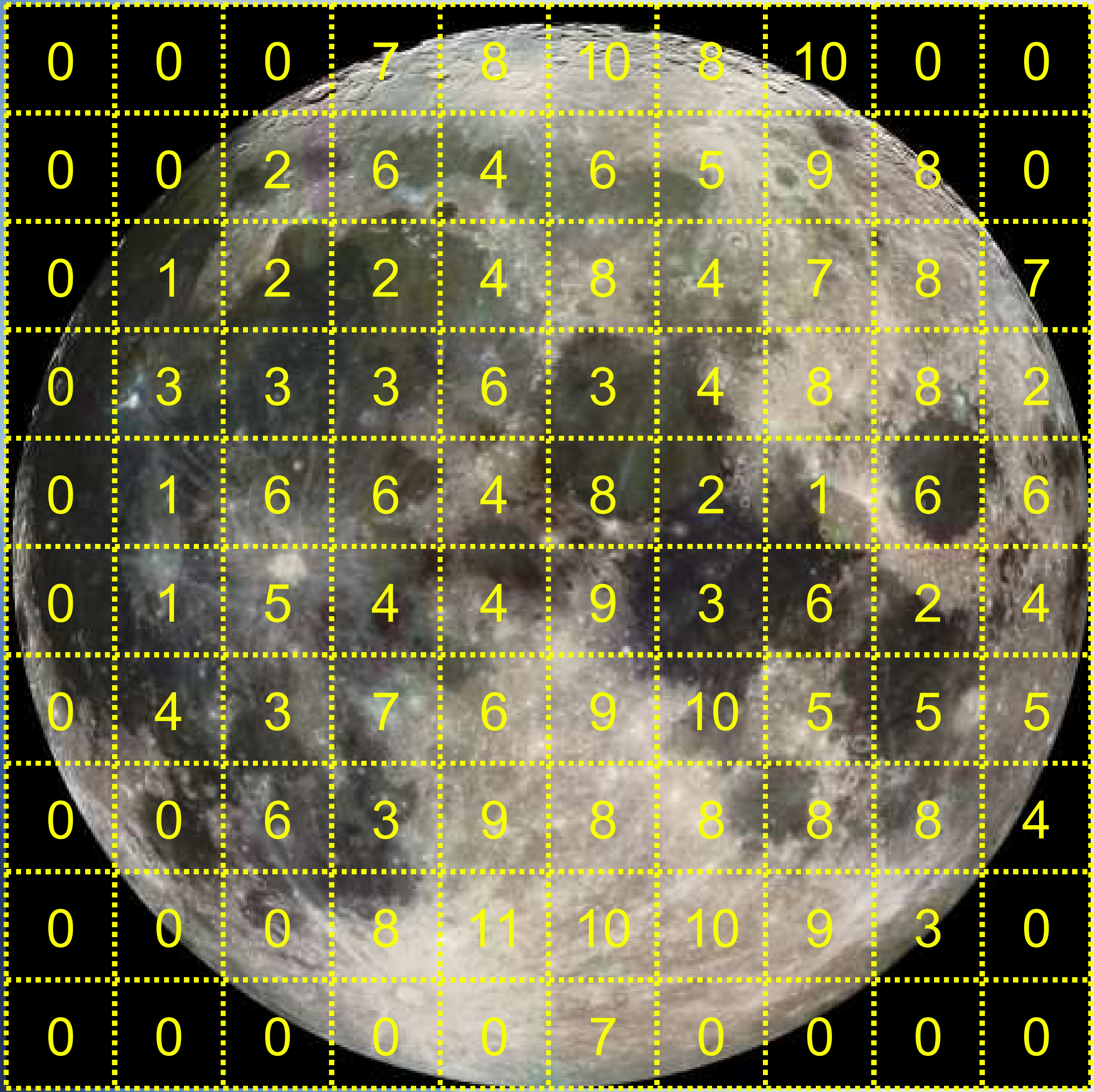
Digital Image Files

Maui Community College

October 23, 2008

The Engineering Design Process





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0	4	3	7	6	9	10	5	5	5
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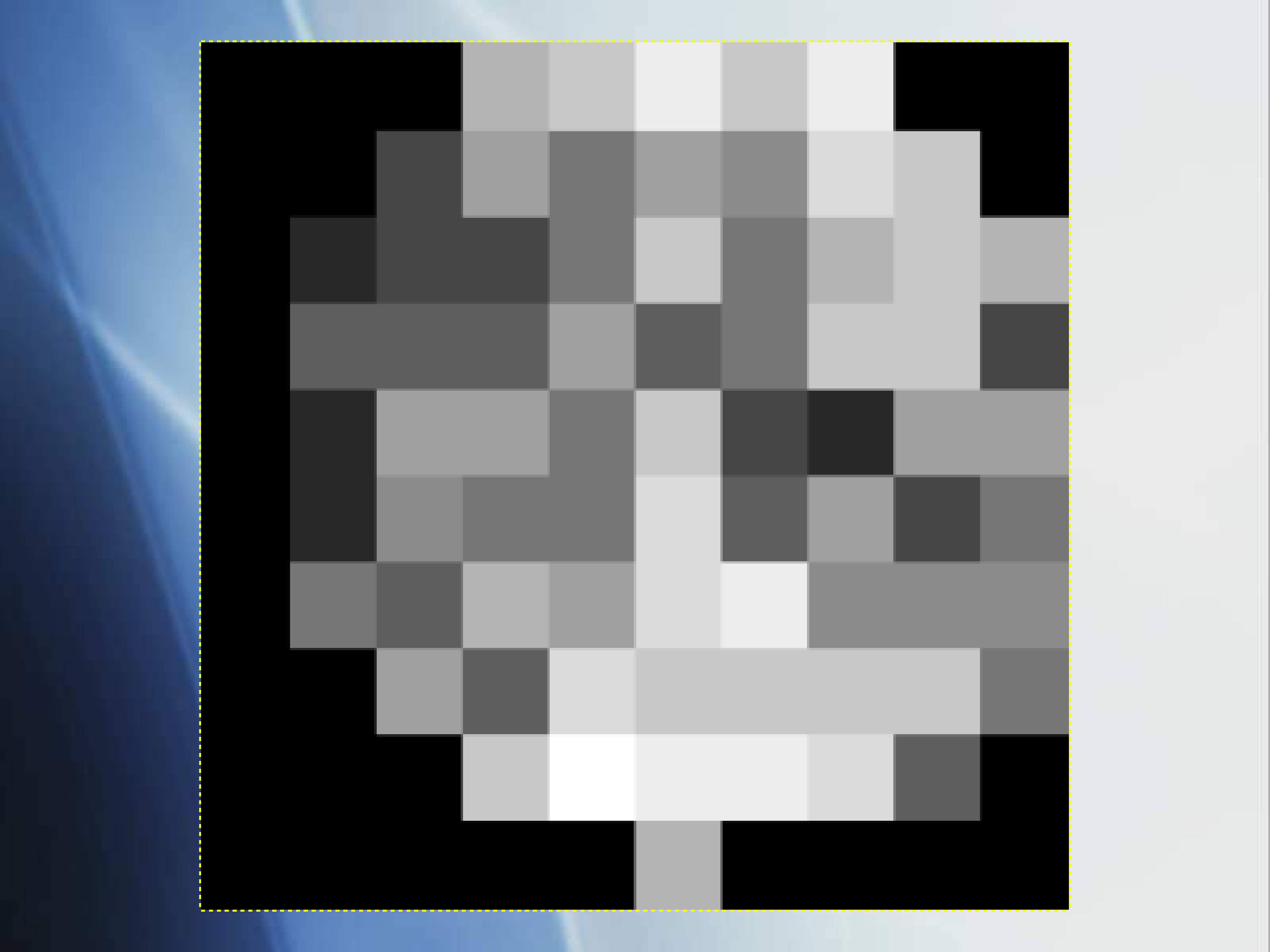
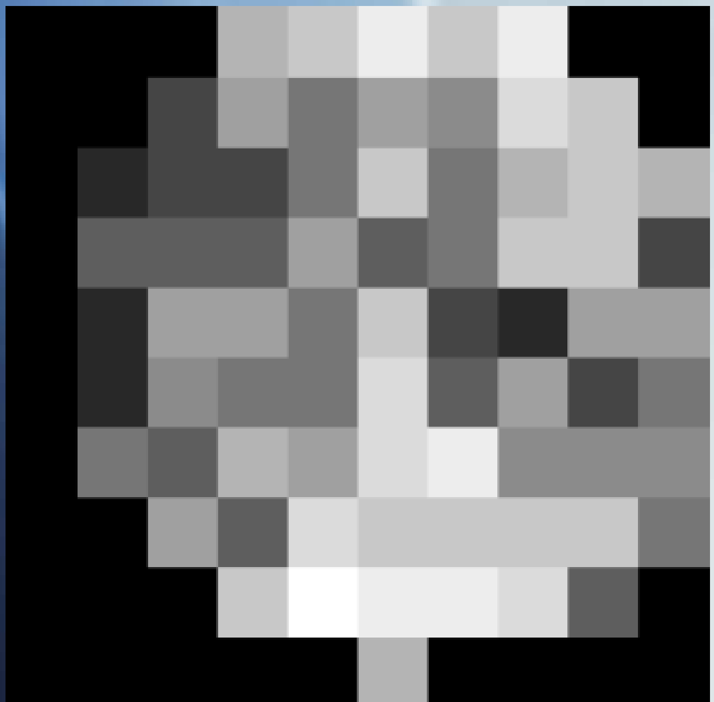




=

0	0	0	7	8	10	8	10	0	0
0	0	2	6	4	6	5	9	8	0
0	1	2	2	4	8	4	7	8	7
0	3	3	3	6	3	4	8	8	2
0	1	6	6	4	8	2	1	6	6
0	1	5	4	4	9	3	6	2	4
0	4	3	7	6	9	10	5	5	5
0	0	6	3	9	8	8	8	8	4
0	0	0	8	11	10	10	9	3	0
0	0	0	0	0	7	0	0	0	0

Pictures can be represented by numbers!

Continuous vs. Discrete

- Real world is *continuous*
- Digital images “break up” a scene - *discrete*
- Breaking up an image into discrete parts means you *lose* information!

Pixel = "Picture Element"

Pixel value - the number associated with a pixel

"Spatial Resolution" measures how well you can distinguish distinct features in an image

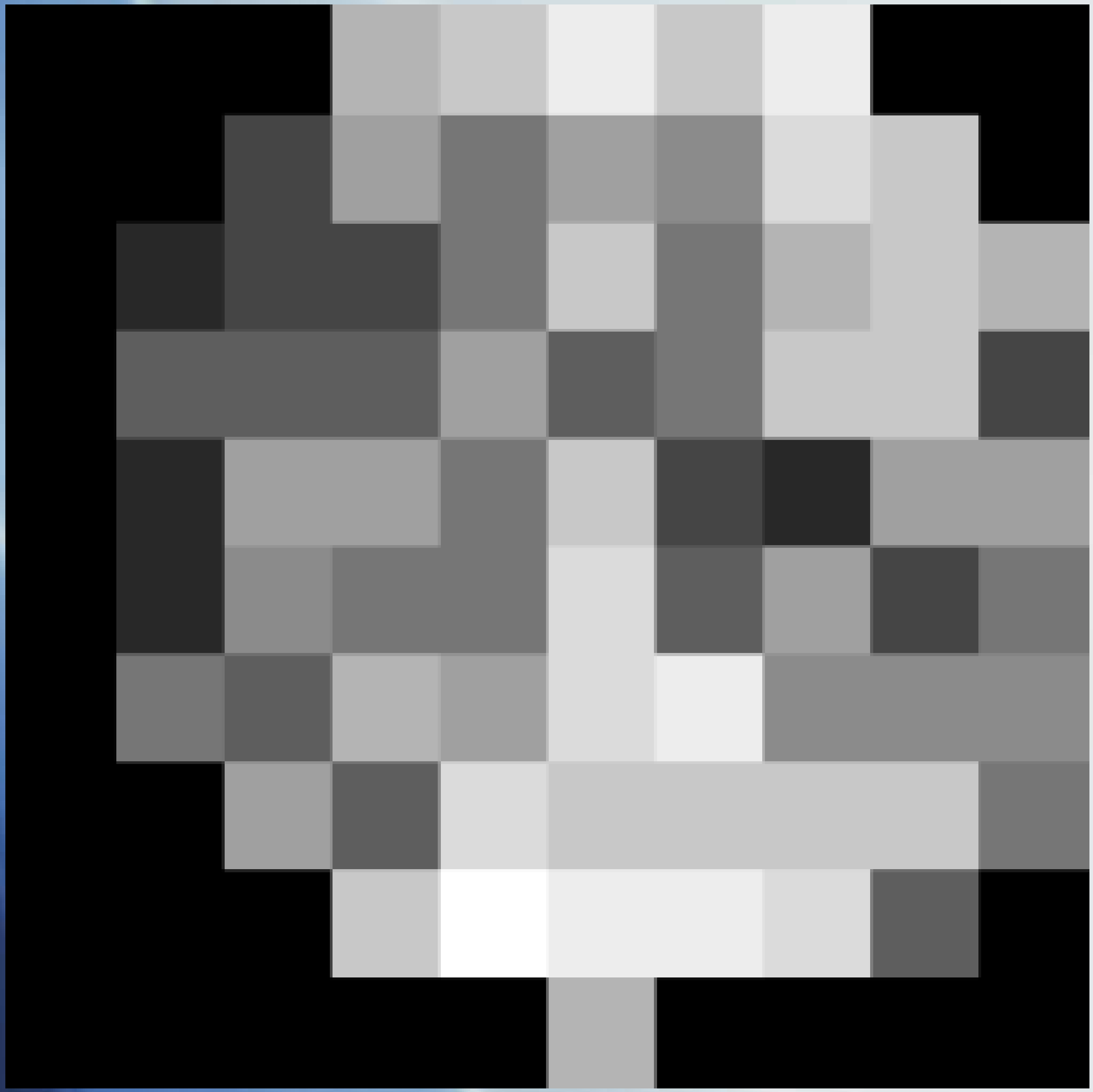
10

0	0	0	7	8	10	8	10	0	0
0	0	2	6	4	6	5	9	8	0
0	1	2	2	4	8	4	7	8	7
0	3	3	3	6	3	4	8	8	2
0	1	6	6	4	8	2	1	6	6
0	1	5	4	4	9	3	6	2	4
0	4	3	7	6	9	10	5	5	5
0	0	6	3	9	8	8	8	8	4
0	0	0	8	11	10	10	9	3	0
0	0	0	0	0	7	0	0	0	0

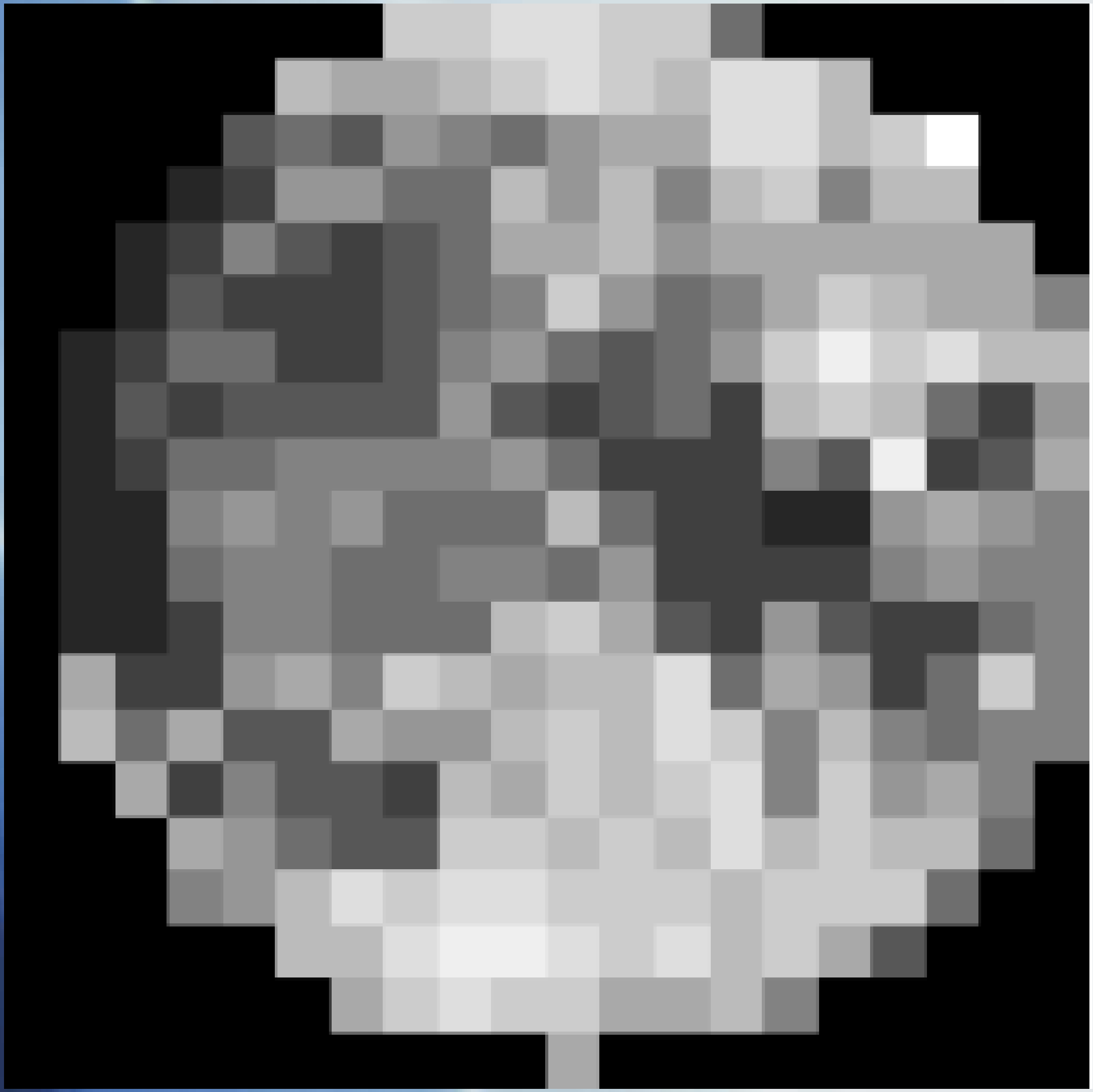
10

Number of pixels determines spatial resolution!

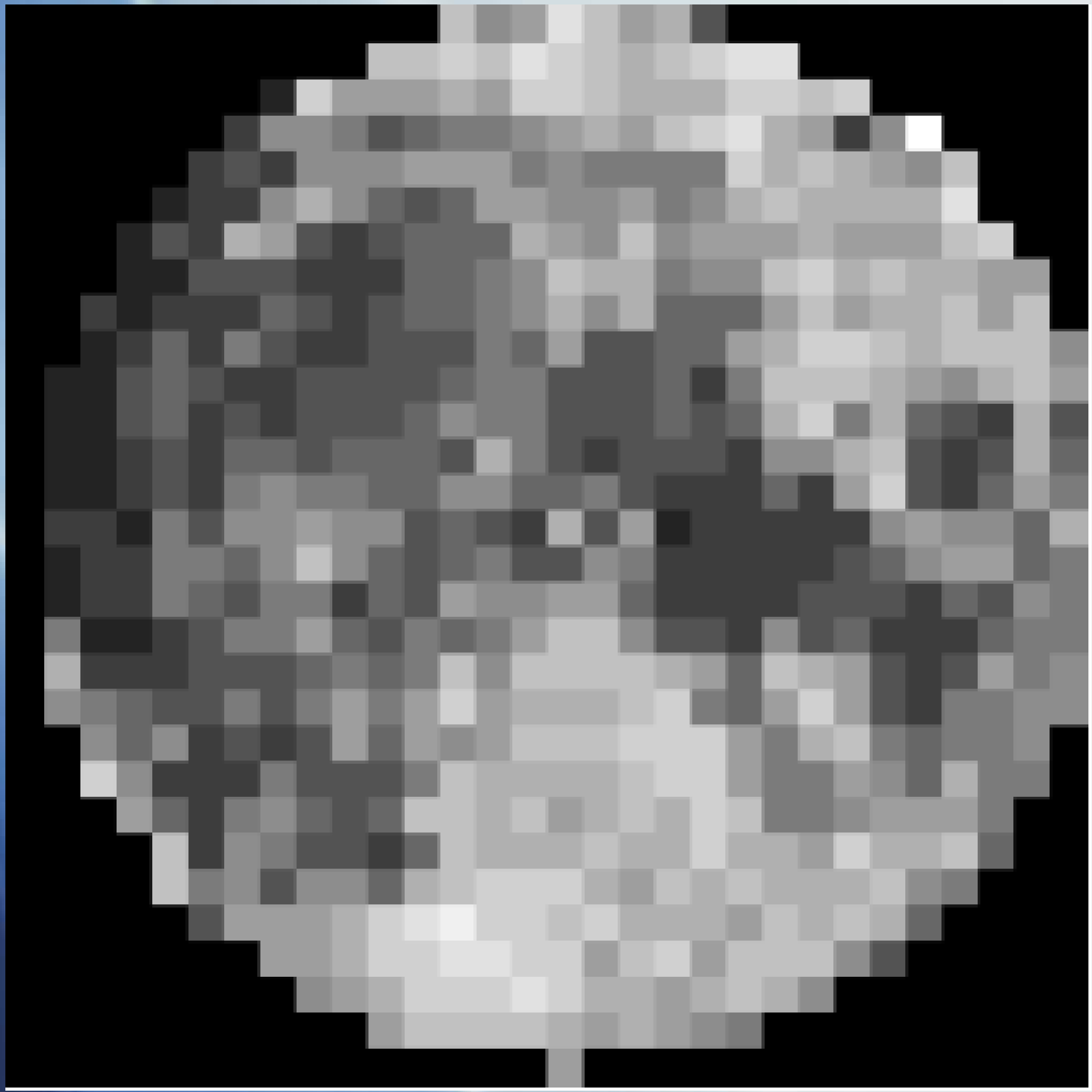
10 x 10 pixels = 100 pixels



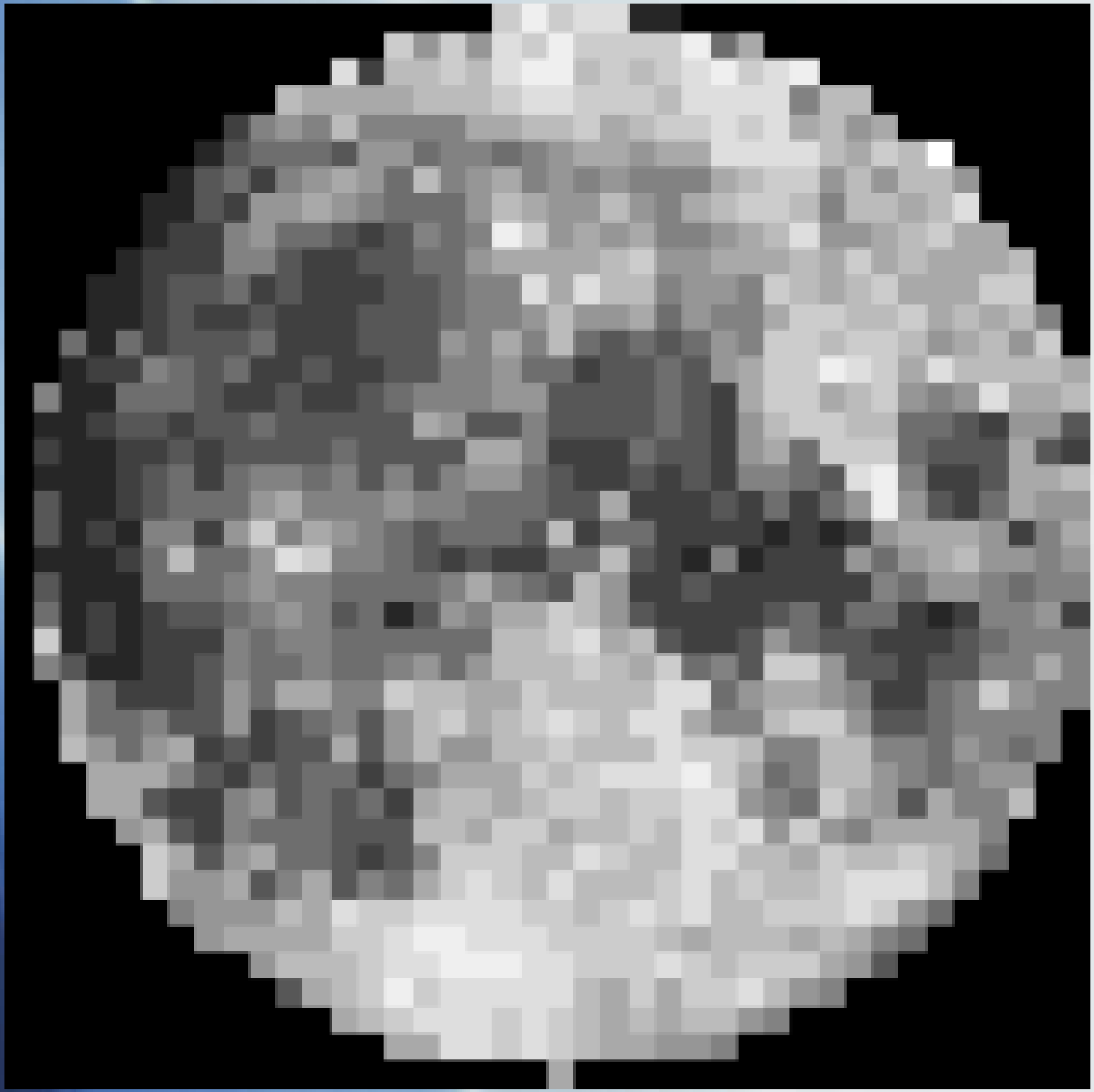
10 x 10 pixels = 100 pixels



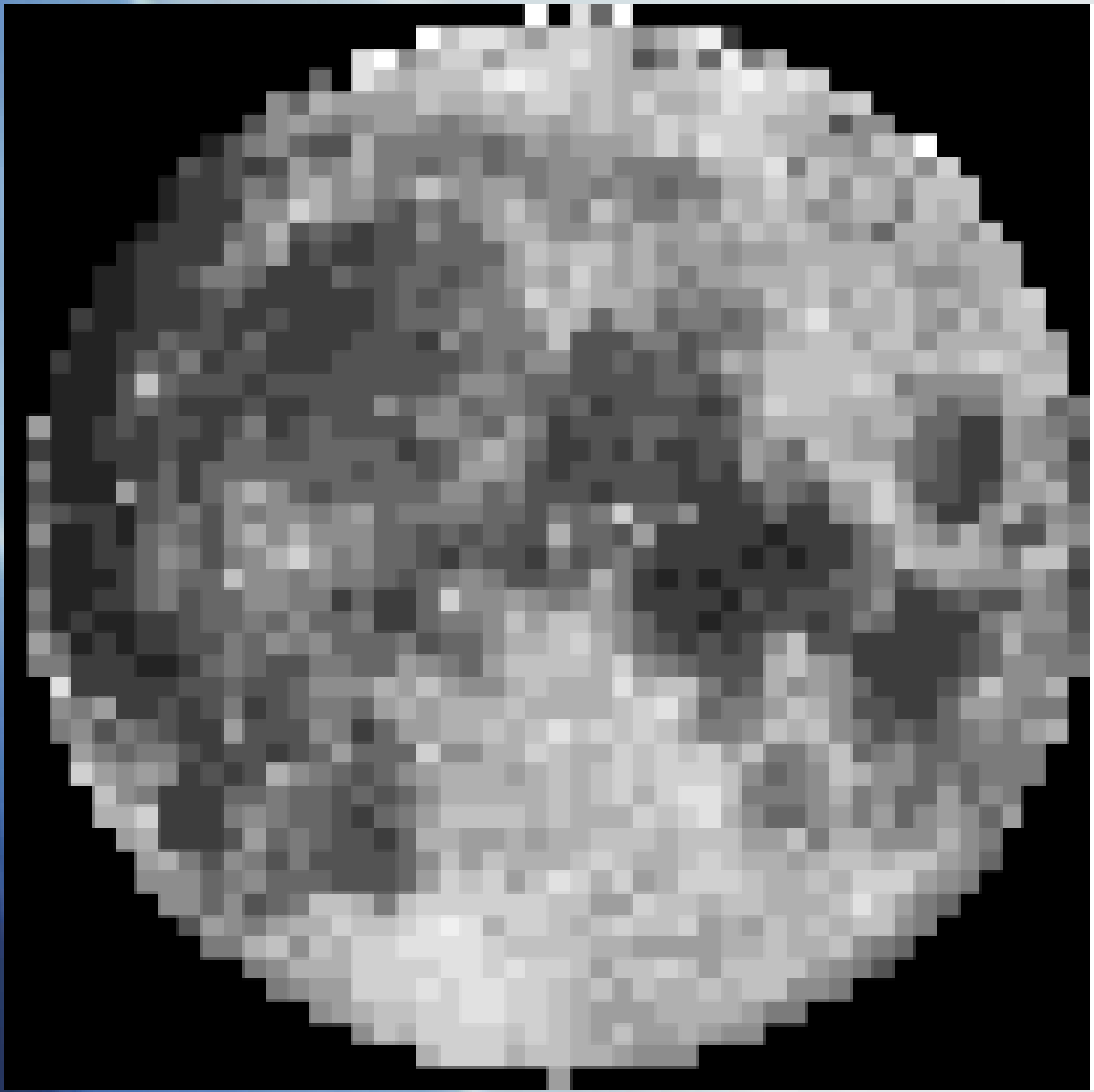
20 x 20 pixels = 400 pixels



30 x 30 pixels = 900 pixels

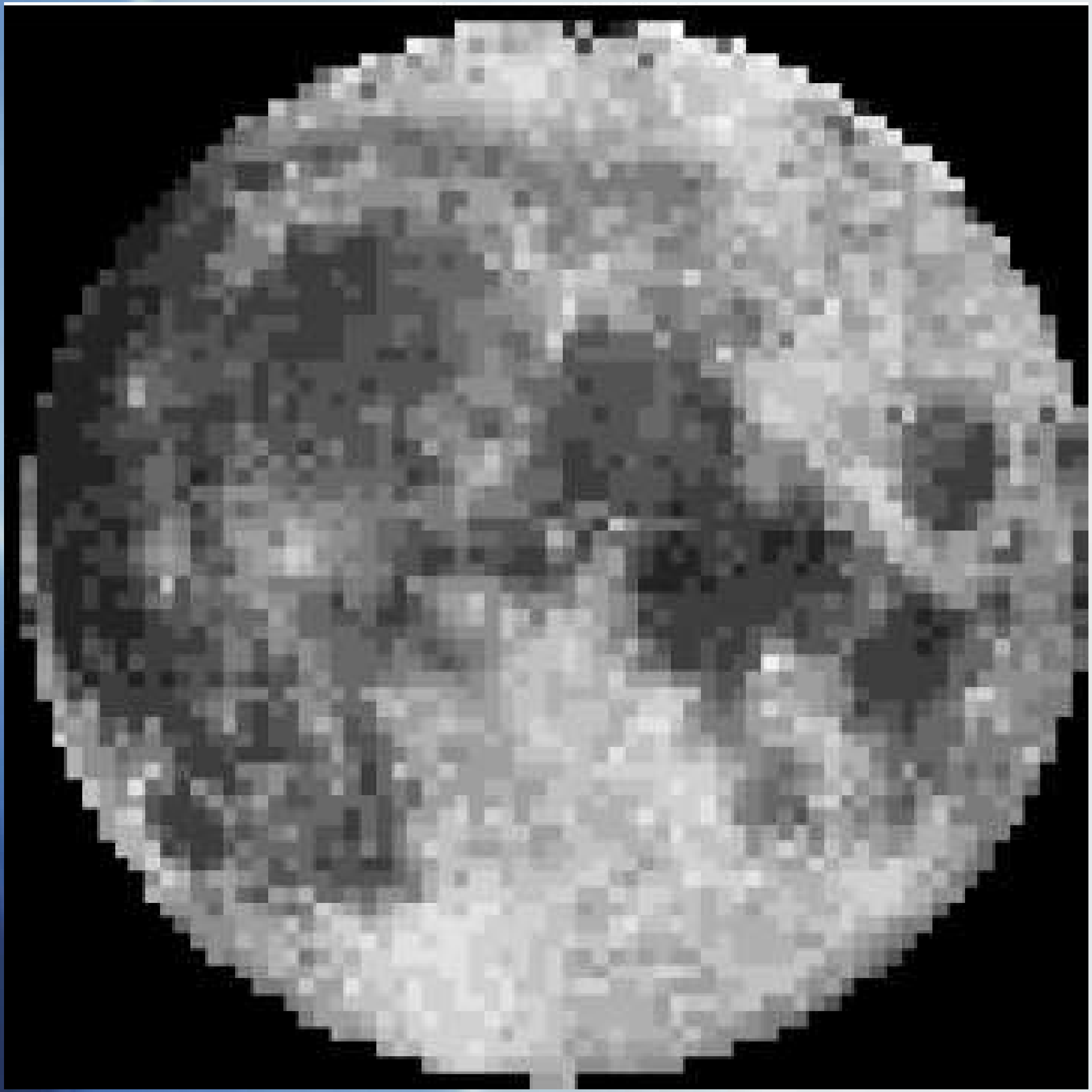


40 x 40 pixels = 1600 pixels



50 x 50 pixels = 2500 pixels

60 x 60 pixels = 3600 pixels



70 x 70 pixels = 4900 pixels

80 x 80 pixels = 6400 pixels

90 x 90 pixels = 8100 pixels

100 x 100 pixels = 10,000 pixels

1986 x 1986 pixels = 3,944,196 pixels

Tradeoffs

More pixels =

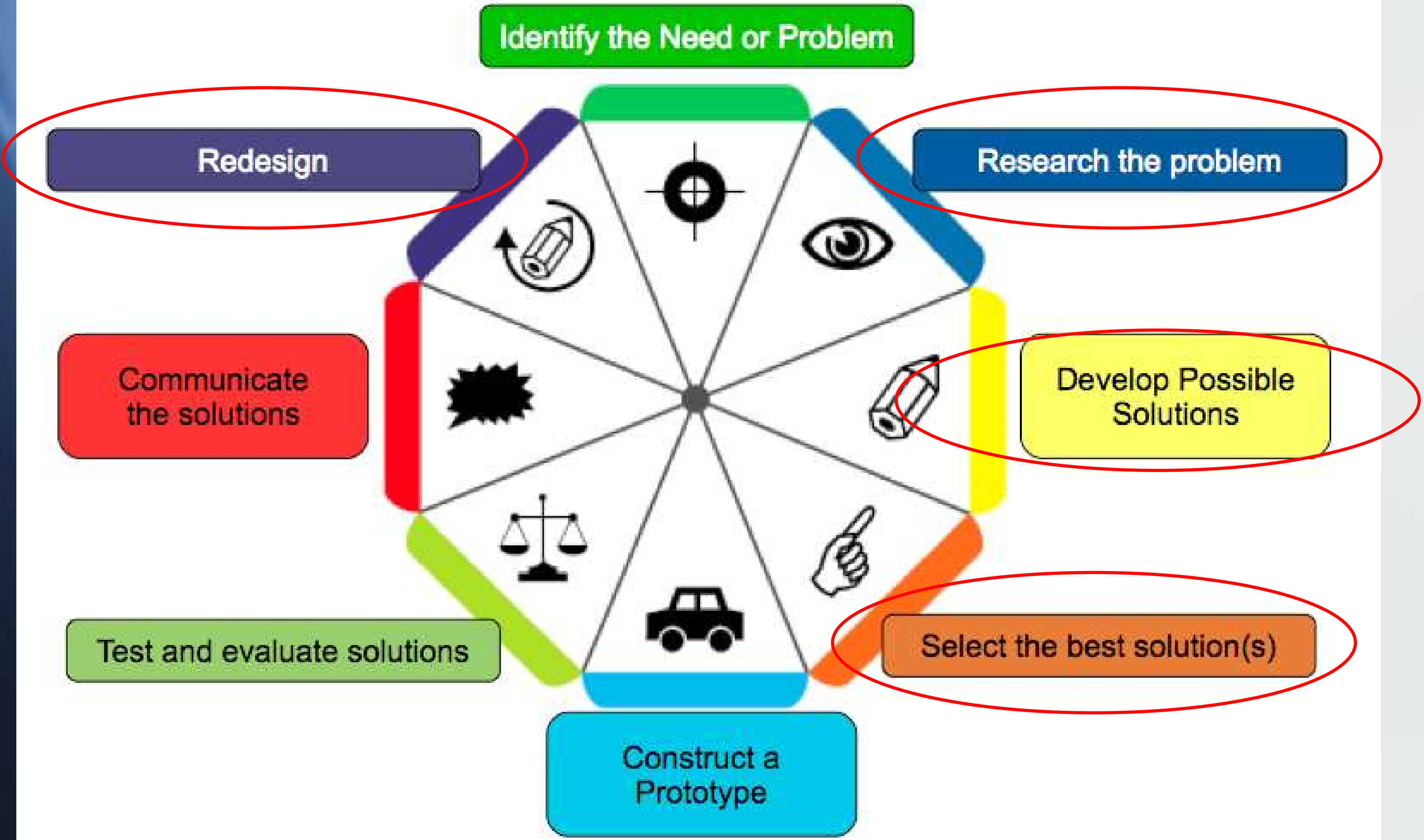
- Greater image detail (better resolution)
- Larger file size
  - More memory
  - Longer to transmit

100 pixels: ~30 minutes

10,000 pixels: ~ 2.3 days

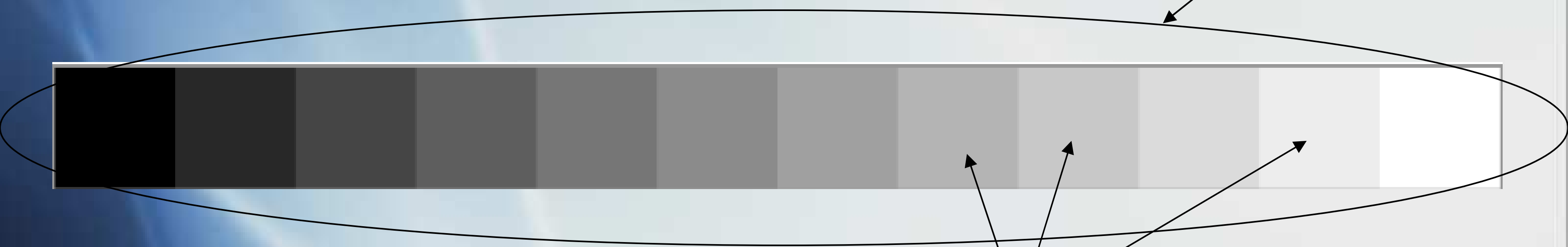
4 million pixels: ~2.5 *years*!!

The Engineering Design Process



Brightness Levels

Infinite number of possible brightness levels BUT only 12 pieces of chalk!



Break up range into 12 "chunks"

"Color resolution" = the ability to differentiate between light levels

Number of color levels determines color resolution!

Color depth = number of colors

- determined by *bits per pixel (bpp)*

1 bpp: 2^1 = 2 colors

2 bpp: 2^2 = 4 colors

3 bpp: 2^3 = 8 colors

4 bpp: 2^4 = 16 colors

5 bpp: 2^5 = 32 colors

6 bpp: 2^6 = 64 colors

7 bpp: 2^7 = 128 colors

8 bpp: 2^8 = 256 colors

More bits per pixel = more colors

= larger file size

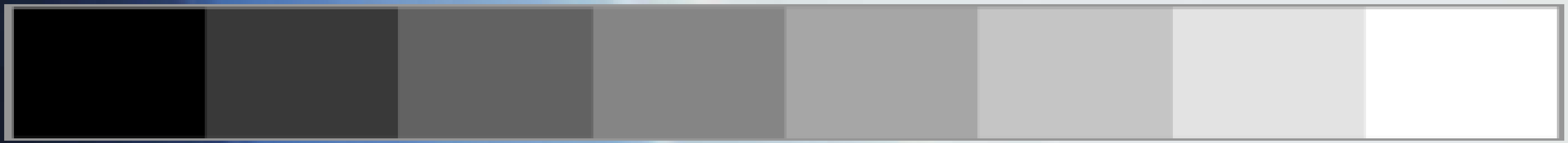
1 bpp

2 color levels

2 bpp

4 color levels

3 bpp



8 color levels

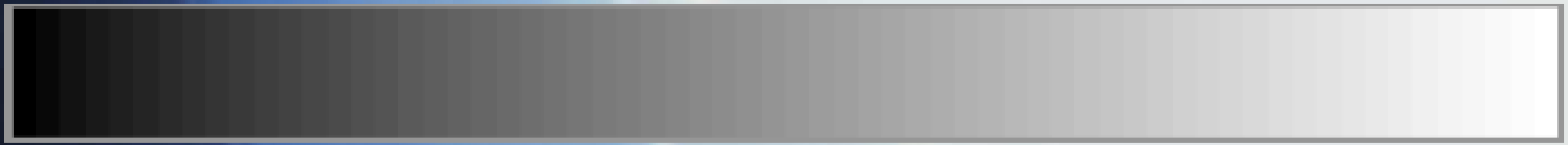
4 bpp

16 color levels

5 bpp

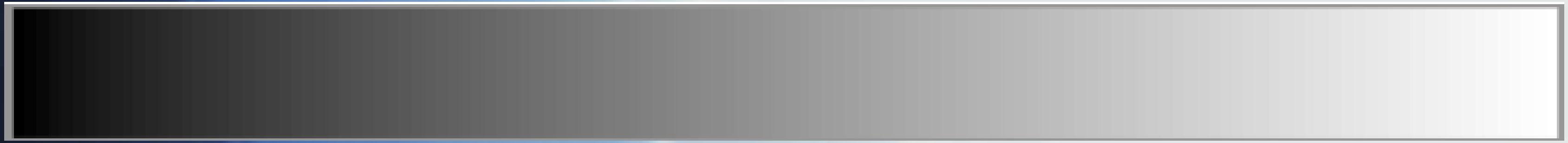
32 color levels

6 bpp



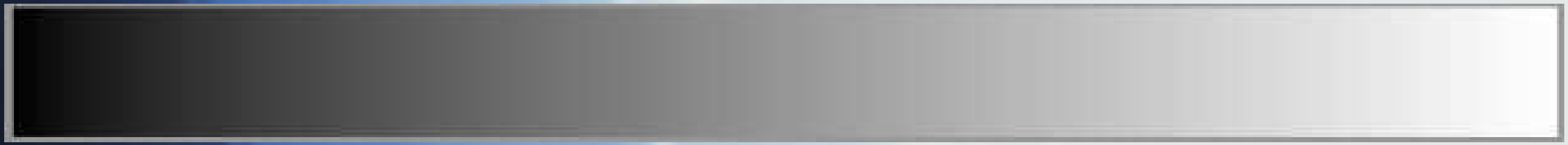
64 color levels

7 bpp



128 color levels

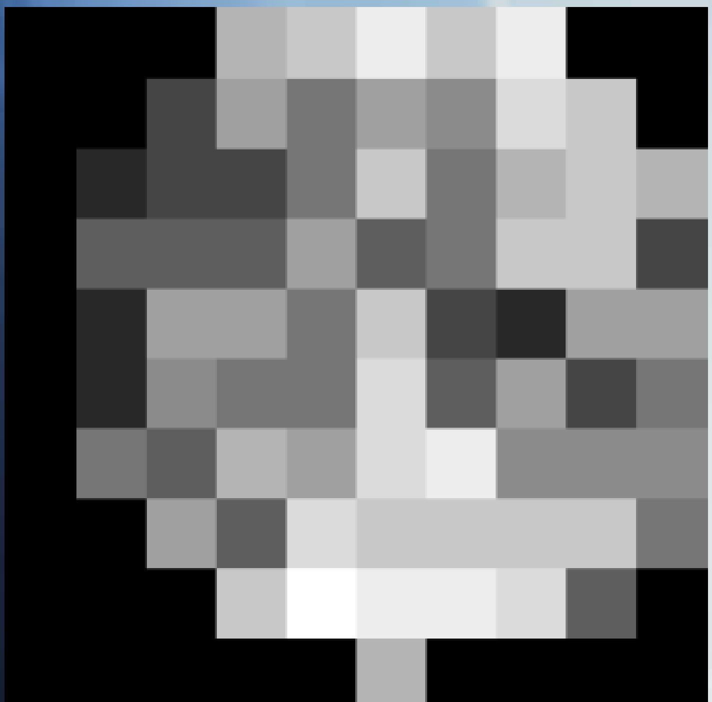
8 bpp



256 color levels

File Formats

PGM Format



Header

```
P2
#fullmoon_10_10_12.pgm
10 10
11
0  0  0  7  8 10  8 10  0  0
0  0  2  6  4  6  5  9  8  0
0  1  2  2  4  8  4  7  8  7
0  3  3  3  6  3  4  8  8  2
0  1  6  6  4  8  2  1  6  6
0  1  5  4  4  9  3  6  2  4
0  4  3  7  6  9 10  5  5  5
0  0  6  3  9  8  8  8  8  4
0  0  0  8 11 10 10  9  3  0
0  0  0  0  0  7  0  0  0  0
```

Body

FITS Format

Header

```
SIMPLE  =                    T / Written by IDL:  Thu Oct  9 17:22:01 2008
BITPIX  =                    8 / Number of bits per data pixel
NAXIS   =                    2 / Number of data axes
NAXIS1  =                   10 /
NAXIS2  =                   10 /
EXTEND  =                    T / FITS data may contain extensions
DATE    = '2008-10-10'         / Creation UTC (CCCC-MM-DD) date of FITS header
COMMENT FITS (Flexible Image Transport System) format is defined in 'Astronomy
COMMENT and Astrophysics', volume 376, page 359; bibcode 2001A&A...376..359H
END
```

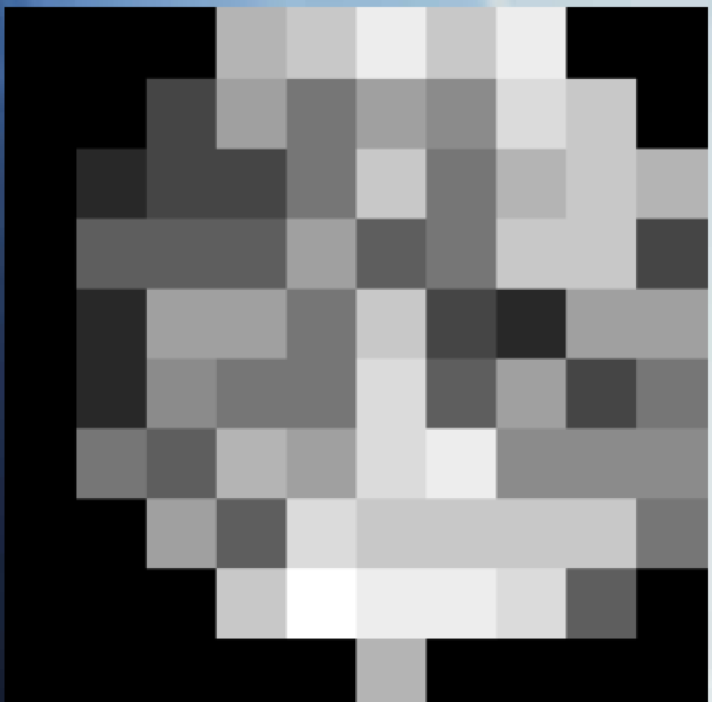
```
00 00 00 00 00 A2 00 00 00 00 00 00 00 BA FF E8
E8 D1 45 00 00 00 8B 45 D1 BA BA BA BA 5D 00 5D
45 A2 8B D1 E8 74 74 74 00 17 74 5D 5D D1 45 8B
2E 5D 00 17 8B 8B 5D BA 2E 17 8B 8B 00 45 45 45
8B 45 5D BA BA 2E 00 17 2E 2E 5D BA 5D A2 BA A2
00 00 2E 8B 5D 8B 74 D1 BA 00 00 00 00 A2 BA E8
BA E8 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

Body

SVG Format

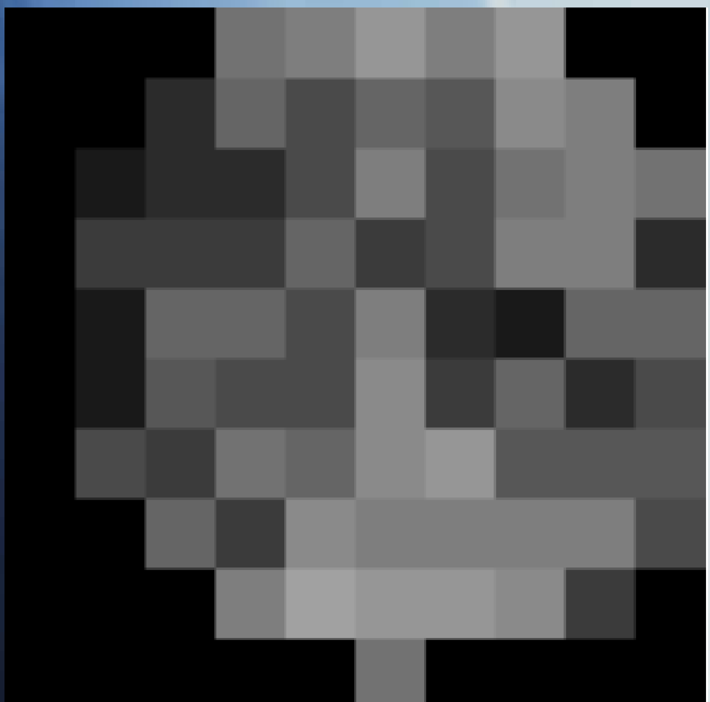
```
<?xml version="1.0"?>
<!DOCTYPE svg PUBLIC "-//W3C//DTD SVG 1.1//EN"
    "http://www.w3.org/Graphics/SVG/1.1/DTD/svg11.dtd">
<svg xmlns="http://www.w3.org/2000/svg" version="1.1"
    width="467" height="462">
  <!-- This is the red square: -->
  <rect x="80" y="60" width="250" height="250" rx="20" fill="red"
        stroke="black" stroke-width="2px" />
  <!-- This is the blue square: -->
  <rect x="140" y="120" width="250" height="250" rx="40" fill="blue"
        stroke="black" stroke-width="2px" fill-opacity="0.7" />
</svg>
```

Image Manipulation



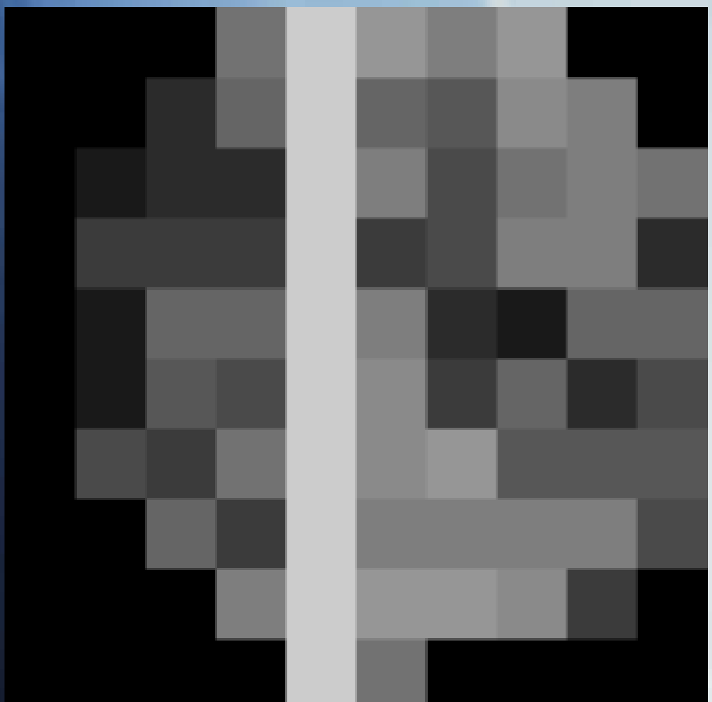
```
P2
#fullmoon_10_10_12.pgm
10 10
11
 0  0  0  7  8 10  8 10  0  0
 0  0  2  6  4  6  5  9  8  0
 0  1  2  2  4  8  4  7  8  7
 0  3  3  3  6  3  4  8  8  2
 0  1  6  6  4  8  2  1  6  6
 0  1  5  4  4  9  3  6  2  4
 0  4  3  7  6  9 10  5  5  5
 0  0  6  3  9  8  8  8  8  4
 0  0  0  8 11 10 10  9  3  0
 0  0  0  0  0  7  0  0  0  0
```

Change image brightness



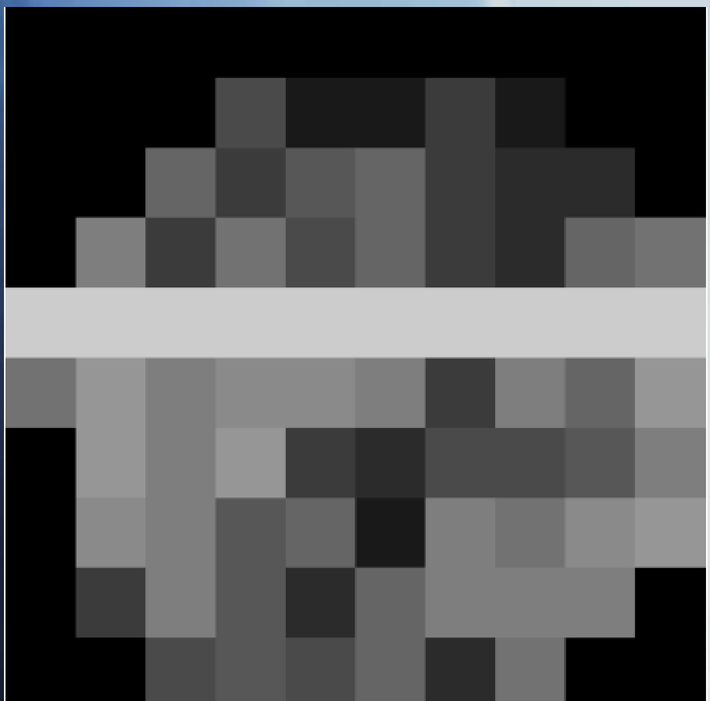
```
P2
#fullmoon_10_10_12.pgm
10 10
20
 0   0   0   7   8  10   8  10   0   0
 0   0   2   6   4   6   5   9   8   0
 0   1   2   2   4   8   4   7   8   7
 0   3   3   3   6   3   4   8   8   2
 0   1   6   6   4   8   2   1   6   6
 0   1   5   4   4   9   3   6   2   4
 0   4   3   7   6   9  10   5   5   5
 0   0   6   3   9   8   8   8   8   4
 0   0   0   8  11  10  10   9   3   0
 0   0   0   0   0   7   0   0   0   0
```

Change image content



```
P2
#fullmoon_10_10_12.pgm
10 10
20
 0   0   0   7  15  10   8  10   0   0
 0   0   2   6  15   6   5   9   8   0
 0   1   2   2  15   8   4   7   8   7
 0   3   3   3  15   3   4   8   8   2
 0   1   6   6  15   8   2   1   6   6
 0   1   5   4  15   9   3   6   2   4
 0   4   3   7  15   9  10   5   5   5
 0   0   6   3  15   8   8   8   8   4
 0   0   0   8  15  10  10   9   3   0
 0   0   0   0  15   7   0   0   0   0
```

Rotate image



```
P2
#fullmoon_10_10_12.pgm
10 10
20
 0   0   0   0   0   0   0   0   0   0
 0   0   0   4   1   1   3   1   0   0
 0   0   6   3   5   6   3   2   2   0
 0   8   3   7   4   6   3   2   6   7
15  15  15  15  15  15  15  15  15  15
 7  10   8   9   9   8   3   8   6  10
 0  10   8  10   3   2   4   4   5   8
 0   9   8   5   6   1   8   7   9  10
 0   3   8   5   2   6   8   8   8   0
 0   0   4   5   4   6   2   7   0   0
```

Summary

- Pictures can be represented by numbers
- Real world is *continuous*; images are *discrete*
- Number of pixels affects
  - Spatial resolution
  - Size of image file
- Bits per pixel (number of colors) affects
  - Color resolution
  - Size of image file
- *Lots* of ways to store a file
  - Standard formats
  - Bitmap vs vector
  - Enough information to reconstruct image (i.e. header)
- Image can be manipulated by mathematical operations on pixel values

Digital Image Files

Glossary of Terms

Words in *italics* are defined elsewhere in this glossary.

Array—A way of organizing information (such as numbers) into a grid that can be addressed by rows and columns.

Bit—Short for "binary digit", this is the smallest piece of information a computer can work with. It is usually represented by the value 0 or 1.

Bit depth—The number of *bits* allocated to each *pixel*. Greater bit depth gives you more brightness levels but takes up more memory.

Bitmap—A method of *digital* image *encoding* where the image is stored as an *array* of *pixels*. Sometimes called a "raster graphic". Compare to *vector graphic*.

Color bar—A graphical way of representing how the brightness levels in an image are mapped to shades of gray or false colors.

Color depth—The number of brightness levels available; determined by the *bit depth*.

Constraint—Limitations enforced on your design. This could come in the form of money, time, or materials. Constraints force you to consider *tradeoffs*.

Continuous—The property of not having any breaks or interruptions; smoothly varying.

Contrast—The difference between the brightness levels in an image.

Digital—Using *discrete* values to store information.

Discrete—Broken into "chunks"; the opposite of *continuous*.

Encode—The process of transforming information from one format to another. For example, taking the light from an object and turning it into an *array* of numbers. ("To code.")

Engineering goals—The parameters of a design which an engineer is trying to achieve. The science goals often help decide these. For example, if scientists want to use an image to map the locations of thousands of stars, your engineering goal is to ensure your imaging camera has high enough *spatial resolution* to distinguish these stars from one another.

FITS—Flexible Image Transport System; an *image file* format commonly used by astronomers. The file contains an expandable *header* and stores the image as a *bitmap*. Can store color information as well.

GIF—Graphics Interchange Format; an *image file* format commonly used on the World Wide Web which uses compression to make an image file smaller at the expense of some image quality.

Grayscale—A type of image in which each *pixel* records only the intensity or brightness; it contains no information on color.

Header—The portion of an *image file* which contains information about the image such as number of rows and columns or what *pixel value* represents "white".

Image file—A computer file which contains a binary representation of an image; generally stored as either a *bitmap* or a *vector graphic*.

JPEG—Joint Photographics Expert Group; an *image file* format commonly used on the World Wide Web which uses compression to make the file smaller at the expense of some image quality.

PGM—Portable Grey Map; a simple *image file* format which stores the image as a *grayscale bitmap*.

Photometer—An instrument which measures the amount of light.

Pixel—Short for "picture element", it is the smallest piece of information in a *digital* image; a single sample in a *bitmap* image.

Pixel value—The number value associated with a *pixel*.

Resolution—Describes the level of detail in an image. This can be divided into *spatial resolution*, which measures how well an image can distinguish the location of objects and *brightness resolution*, which measures how well an image can measure different levels of light intensity.

Science goals—For an image, this defines what a scientist is trying to achieve by recording a particular image. For example: counting sunspots, measuring the brightness of stars, or mapping the spiral arms of a galaxy.

SVG—Scalable Vector Graphics; an *image file* format commonly used on the World Wide Web to store *digital* images in a *vector graphics* format.

Tradeoff—The act of gaining one property at the expense of another. For example, in images, we gain *spatial resolution* by using *image files* which are larger at the cost of taking up more computer memory. If there were no *constraints* then there would be no need to make tradeoffs.

Vector graphic—The use of predefined shapes and equations to encode a *digital* image. Compare this to a *bitmap*.

ETRO 102 – Instrumentation for Engineering Technology
Digital Image Files: Post-activity Feedback Form **Akamai Workforce Initiative**

1. Feedback on this week's activities

Please rate the various components of the Digital Images activity, and provide any comments next to your rating: this will help us make a more engaging and informative activity for future students. If you did not participate in an activity, just write "N/A".

1	2	3	4	5
not valuable at all	minimally valuable	neutral	fairly valuable	very valuable

Activity	*Rating*	*Comments about your rating*
a. Starter activities (flags, moon pictures, photometers, happy faces)		
b. Focused investigation: measuring and encoding your image		
c. Homework assignment: image file creation and reflection paper		
d. Image decoding: reconstructing another group's image.		
e. Discussion and group sharing		
f. Computer activities		
g. Synthesis discussion: bringing it all together		

2. What are a few important or valuable things you learned in this activity?

3. What new questions do you have, or ideas you want to further explore?

ETRO 102 – Instrumentation for Engineering Technology
Digital Image Files: Final Report **Akamai Workforce Initiative**

Visiting Instructors from the AWI Teaching and Curriculum Collaborative:
Katie Morzinski (UC Santa Cruz, Lab. for Adaptive Optics), Chris Crockett (UC Los Angeles), Ian Crossfield (UC Los Angeles), Kalei Tsuha (AWI consultant), Lisa Hunter (AWI Director);
Scott Seagroves (AWI curriculum specialist)

PLEASE READ THIS ENTIRE ASSIGNMENT CAREFULLY. READ THROUGH ALL THE QUESTIONS *BEFORE* YOU START WORKING.

Your homework is to prepare a short report on this week's activity. This report should be typed and double-spaced; with a normal-looking font and font size, the assignment should be *roughly* 2-3 pages. These guidelines are only so you know about how big the report should be, and to help it be neat and easy to read.

Rather than asking you to come up with an entire report out of thin air, we would like you to address the following questions instead. These questions are meant to guide you toward the issues that we think are important. You should clearly address each section by numbering your responses on your report.

Many sections have more than one question. Please address the section as a whole, writing in complete sentences and paragraphs so that your series of answers is logical and clear without us having to constantly refer back to the questions themselves.

To give you an example, your report might start (after your name):
"1. FOCUS
Our group had to make a digital image file out of a picture of a *honu*. The science goal was that others should be able to measure the size of the turtle from the image. So we took that to mean that color was not important."

You may talk to your classmates (in particular your group members) to help you remember things, but you must write your report on your own, in your own words.

1. **WHAT YOU FOCUSED ON 1pt**
   a. What image were you trying to encode?
   b. What kinds of science goals were you given about the image?
2. **MOTIVATION FOR THIS FOCUS 2pt**
   a. What is interesting about the particular image you were given?
   b. What is interesting about the challenge of encoding it?
   c. What is interesting about the science goals your encoding had to meet?
3. **YOUR PREVIOUS EXPERIENCE 2pt**
   a. What did you already know about digital images or digital image files before this activity?
   b. What did you learn during the introductions and start of the activity that related to your image encoding challenge?
4. **YOUR PREDICTIONS AND FIRST IDEAS 3pt**
   a. What was your initial plan for encoding the image while meeting the science goals and staying within budget?
   b. Was there anything about your plan that you weren't sure about at the beginning?
5. **YOUR INVESTIGATIONS AND YOUR WORK 4pt**
   a. How did you initially try to encode your image?

   b. What kinds of things did you consider or try, even if they didn't work out?

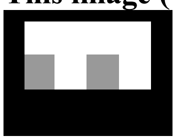
6. **MODIFICATIONS AND CHANGES TO YOUR PLANS AS YOU WORKED 3pt**
   a. Did you need to adapt or change your initial plans? If so, how did your initial plans or ideas for encoding the image change?
7. **YOUR NOTES, DATA, AND RECORDINGS 2pt**
   a. As you worked to encode your image, meet the science goals, and stay within budget, what sorts of things did you have to write down? (E.g., measurements you made, notes you took, or data collected, etc.)
8. **YOUR EFFORTS TO INTERPRET YOUR INVESTIGATION 3pt**
   a. How did you try to make sense of your work? For example, did you make any charts or plots, or do any calculations regarding your budget? Did this lead you to any conclusions or new ideas?
9. **YOUR GROUP'S SOLUTION 5pt**
   a. What method did your group ultimately come up with to encode your image and meet the science goals?
   b. How well did the image decoded by others match your original image?
   c. How well did your encoding work, and how did you assess or determine this?
10. **TRADEOFFS, PROS AND CONS, OF YOUR SOLUTION 5pt**
   a. Was your image encoding method able to do everything? For instance, could it have encoded the other images in the class, with different science goals?
   b. Did you notice that in order to get some features and stay within budget, you had to sacrifice other features? Describe and give an example of the tradeoffs you had to make
11. **CONSTRAINTS THAT FORCED TRADEOFFS IN YOUR SOLUTION 5pt**
   a. Assuming your group had to deal with some tradeoffs, what were the constraints that were keeping you from being able to achieve everything all at once?
   b. Besides the budget, discuss other constraints imposed upon you in this project.
12. **THE LIMITATIONS OF YOUR CONCLUSIONS 4pt**
   a. Please describe the limitations of your ideas and conclusions about digital image files. In essence: what is there that you still don't know or understand about this topic?
   b. Were there ideas that you were unable to test?
   c. How would you figure out if you had achieved the *best* image-encoding solution you could?
13. **YOUR FINAL REFLECTION 3pt**
   a. Finally, we want you to reflect on the activity. What skills and attitudes were needed to succeed in a team-oriented activity?
   b. What skills and attitudes were needed to succeed in an engineering design activity?
   c. What skills and attitudes would you like to improve for future activities, jobs, and life?
14. **YOUR IDEAS FOR FUTURE ENGINEERING PROBLEMS (up to 3 pt. extra credit)**
   a. Suppose, in the future, you are again faced with a constrained engineering problem. You want to come up with the best solution possible that meets your goals and requirements but still works within the constraints:
   What ideas do you have for how you might evaluate and compare different possible solutions? How can you know if you are making a good choice? This question is very open-ended, so feel free to put down whatever ideas you have.

An example *.pgm* file

```
P2
# foo.pgm
4   3
10

10 10 10 10
 5 10   5 10
 0   0   0   0
```

This image ("foo.pgm") looks like this:



What does each part mean?

Header:

P2	*Tells the computer that the file format is* .pgm *(portable gray map).*
# foo.pgm	*Name of file. The # tells the computer to ignore this line (it is a comment).*
4 3	*Width and height of image. The image is 4 pixels wide by 3 pixels high. (In other words, there are 4 columns and 3 rows.) There must be a space between the width and the height.*
10	*Maximum value of a pixel. The brightest pixel is 10 (white). 0 is the minimum (black will be 0).*

Body:

10 10 10 10	*The first row. There are 4 pixels. Each pixel has the value 10 = white.*
5 10 5 10	*The second row. There are 4 pixels. Two pixels have the value 5 (gray). Two pixels have the value 10 (white).*
0 0 0 0	*The third row. There are 4 pixels. Each pixel has the value 0 = black. (See the picture above.)*

Name: ___________________________________

Digital Image Files
Computer Lab Assignment

Directions:
Part 1

1. Create a new folder for your work entitled "*yourname*_DigitalImageFiles"
2. Download the image file that corresponds to the image you encoded and save it in the new folder you just made: (Choose one:)
   Moon: http://inquirydesign.atwiki.com/file/open/21/fullmoon.pgm
   Sunspots: http://inquirydesign.atwiki.com/file/open/21/sunspots.pgm
   Jupiter: http://inquirydesign.atwiki.com/file/open/21/jupiter.pgm
   Saturn: http://inquirydesign.atwiki.com/file/open/21/saturn.pgm
3. Use the text editor *Notepad* to open the image that you encoded (start up the *Notepad* application and then select File -> Open -> *yourimage*.pgm).
   - ☐ Look at the handout "An example *.pgm* file" and identify the header and the body in *yourimage*.pgm.
   - ☐ Turn to your neighbor and show them the header and body of your image.
   - ☐ Check that your neighbor identified the header and body in their image.
4. Now use the image viewer *Irfanview* to open the image (start up the *Irfanview* application and then select File -> Open -> *yourimage*.pgm).
5. Notice: You just opened the same file two different ways.
   - ☐ When you opened it with *Notepad*, it was made of numbers and characters.
   - ☐ When you opened it with *Irfanview*, it was an image.
6. Now close the file in *Irfanview*.
7. Go back to the file in *Notepad*.
   - ☐ Change the value of the upper-left pixel in the body.
   - ☐ Save the file.
   - ☐ Open the file in *Irfanview*.
   - ☐ What happened to the upper-left pixel?
   - ☐ Close the file in *Irfanview*.
8. Go back to the file in *Notepad*.
   - ☐ Make the image 50 color levels darker.
   - ☐ Save the file.
   - ☐ Open the file in *Irfanview*.
   - ☐ Check that it is darker.
   - ☐ Close the file in *Irfanview*.
9. Go back to the file in *Notepad*.
   - ☐ Remove the last row of pixels.
   - ☐ Save the file.
   - ☐ Open the file in *Irfanview*.
   - ☐ Check that the last row of pixels was removed.
   - ☐ Close the file in *Irfanview*.

Part 2

10. First you have to save the file with a ".txt" extension. It will still be the same file, but *Excel* won't open a ".pgm" file even though both contain text. So make a copy of the file in your folder, and save the copy as ".txt" (i.e. *sunspots.txt* or *jupiter.txt*).
11. Open *Excel* and read in the file by following these steps:
    - ☐ File -> Open -> *yourimage*.txt
    - ☐ Select "Delimited"
    - ☐ Select "space" and "tab" and "treat consecutive delimiters as one"
    - ☐ "Finish"
12. Now try manipulating the image in *Excel*, always looking at it in *Irfanview* to see what effect the change had. You will have to save it as delimited text, then rename the file from *yourimage.*txt to *yourimage*.pgm so that *Irfanview* will view it as an image.
    - ☐ Add a new column of black pixels, somewhere in the middle. Check to make sure the change happened in *Irfanview.* Do you have to change just the body, or also the header?
    - ☐ Add a new row of white pixels, somewhere in the middle. Check in *Irfanview.*
    - ☐ Flip the image upside-down. Check in *Irfanview.*
    - ☐ Make the negative-color image. Check in *Irfanview.*
    - ☐ Change the number of colors to use fewer colors. Check in *Irfanview.*
    - ☐ Try rotating the image 90 degrees. Check in *Irfanview.*

Materials/Supplies for "Digital Image Files" Inquiry

ITEM	QUANTITY	VENDOR	PART NUMBER
Laptop	1		
Projector	1		
Digital photometers	8	Industrial Fiber Optics	IF PM
Artist's pastel chalks, 12 shades of grey, box set	2	Art Alternatives	AA17772
Artist's pastel chalks, 12 shades of color, box set	8	www.Art-Alternatives.com	AA17770
Plain white paper	1 ream		
Large flip-chart paper, plain	1 pad		
Large flip-chart paper, gridded	1 pad		
Batteries for photometers	8		
Paper sentence strips, for writing questions	About 200		
Rulers	8		
Compasses	8		
Protractors	8		
100-Watt light bulbs	9		
40-Watt light bulb	1		
300-Watt light bulb	1		
Power strips	12		
File folders, any color (basically a thick piece of paper, folded in half once)	24		
Tape (masking/painter's, and duct)	4		
Light bulb sockets/holders that plug into power strip	12		
extension cords	6		
empty boxes (e.g., Xerox boxes)	8		
clear plexiglass panels (box covers)	8		
Color filters and/or cellophane			

In addition, copies of all the necessary papers from the printed activity documentation.

Student Observations and Questions:
Sentence Strips from 2008

We only have a partial record of the sentence strips from 2008, but they give a representative sample of the students' views and should help prepare in advance for the sentence strip sorting and the Starter Mini-synthesis. These have been slightly edited for readability.

1. Transmitting images
   1. The order of when shapes were described mattered (and was hard to plan)
   2. Imprecise. Slow. Needs a language to describe. Needed protocols to not waste time and interest.
   3. Would have been much easier with eye contact.
   4. Two-way communication is helpful.
   5. People describing the image started with the background.
   6. How do you communicate scale within a flag?
2. Measuring Light Levels With a Photometer:
   1. Notice the photometer had to be held farther away from the higher wattage light sources
   2. The position of the paper and light changes the photometer reading
   3. I notice the measurement gets smaller when the photometer is further away
   4. The darker the spot on the sheet of paper through which the light goes, the lower the measurement on the photometer
   5. The closer to the light bulb, the higher the number on the photometer
   6. How do photometer measurements change with different locations on the light box?
   7. How much does turning off the room lights change the readings?
   8. At a fixed distance, the measurements seemed comparable to lamp power.
   9. Reading varied smoothly with gradients.
3. Evaluating Tradeoffs:
   1. What would be done to make the large image clear?
   2. Is there a 'sweet spot' between 'good enough' quality and too big of a file size?
   3. The detail of the stars and numbers made it difficult to describe the flag.
   4. Less data = easier to transmit/process.
   5. From first image on left to last image on right, the image becomes less detailed, lots of gray to none.
   6. The quality of the image has changed from detailed to less detailed.
   7. Zooming in on certain types of images with low quality loses a lot of the pixels
   8. The resolution changes dramatically
   9. Why did one set of the moon pictures not have that good of a resolution when it was being enlarged?
   10. Why are some of the encodings longer than the others?
   11. The analog pictures show good shape, even at first, and suffer less than the pixellated ones
4. Information Content
   1. Why did the image lose its details?
   2. Detail is lost in the high contrast image.
   3. Images get less focused as the resolution gets lower
   4. The shading and depth and color changes
   5. How are large pixels important in defining and interpreting information?
   6. How many megapixels are needed for a sharp and clear image?
   7. The more pixels there are, the overall quality of the images gets better and better

8. The image quality is not clear with limited picture elements (pixels)
9. What do the different shades of gray represent?
10. The size of the pixels gets larger and less detailed.
11. The image seemed to change in contrast. It started off in many different colors and ended up mainly two colors (white and black)
12. What makes the image lose depth? Loses its clarity?
13. What would you use the blocky image for?
14. How many times is it magnified in the block image?
15. I would like to know more about pixels and what their differences are.

5. Image File Formats
    1. Most data files (arrays) seem too big
    2. 2 bit depth image; 10x10 pixel array; binary encoding most simple
    3. The image drawn is not as detailed as the other one, but pretty close
    4. With the different # of grays the numbers were either more or less in different shades of gray
    5. Is any one language more efficient than any other?
    6. Is there anyone besides a computer that is able to read these codes?
    7. I believe that each pixel has its own number that represents its number in grayscale.
    8. Why are the pixels represented in hex? And in pgm in binary?
    9. What are the letters and numbers for?
    10. I notice most of the numbers are 0 and 1. I think the computer only understands 0 and 1.
    11. How does the picture form with the different encoding?
    12. What are the advantages with different picture formats?
    13. How do you use codes to make the same image?
    14. Why do some images have a lot of numbers and some get a little?
    15. Why are there so many different file types?
    16. Which format will produce the best quality image?
    17. Some file formats are easier to read by a human. Are these less efficient/not as useful?
    18. The portable gray map is very easy to understand.
    19. The compressed formats JPEG, PNG are unreadable.
    20. Each one is formatted differently but all of them appear to be the same image.
    21. Why are there so many ways to represent an image?
    22. Is there an advantage in using a short program versus a “long” one if the result is the same?

Image: Sun with sunspots (S)

Overview: You have an image. By the end of today's investigation, you will have made an "image file" of your picture. On Thursday you will pass your image file to another group, who will draw it without seeing the image. This is similar to the "Flags" starter, but using written communication instead of spoken communication.

Overall scientific goal: Differential rotation rate of sun
Intermediate step: Map of location of sunspots
Description:

You are a member of an engineering team. Your team is working on a project to study the rotation rate of the sun. The sun's equator does not rotate at the same rate as the sun's poles; this is called *differential rotation*. The image you have is a close-up picture of some of the sun's sunspots, taken with the Swedish 1-m Solar Telescope on the Canary Island La Palma in 2002. The sunspots remain present on the surface of the sun long enough to rotate around the sun at least once, so they can be used to measure the differential rotation rate.

Your task is to come up with a way to digitize this image that transmits sufficient information for the differential rotation rate of the sun to be measured. Think of it as designing an instrument to measure and record images of the sun, with the goal of measuring the differential rotation rate. Do this by encoding this image of the sun in a way that allows another group to reconstruct the image towards the goal of measuring the differential rotation rate of the sun.

Constraints:
Time: 1 hour
Materials: Those in this room, or you may ask your facilitators if you have a specific supply request.

Additionally, you have to work within a budget. The cost of your image can be calculated as:

C = A*nbrt*nsam + B*(nchar - nsam)
where
C = total cost
A = cost per brightness level
B = cost per character
nbrt = number of brightness levels (if applicable)
nsam = number of photometer samples (if applicable)
nchar = total number of characters used to encode your image

You are free to design your image file format however you'd like, given the following constraints:
Budget = $1000
A = $2
B = $1
Maximum number of brightness levels = 12

Image: Sun with sunspots (C)

Overview: You have an image. By the end of today's investigation, you will have made an "image file" of your picture. On Thursday you will pass your image file to another group, who will draw it without seeing the image. This is similar to the "Flags" starter, but using written communication instead of spoken communication.

Overall scientific goal: Temperature of sunspots with respect to the photosphere
Intermediate step: Brightness of sunspots with respect to the photosphere
Description:

You are a member of an engineering team. Your team is working on a project to study the temperature of the sun's sunspots. A sunspot is a large dark region on the surface of the sun with a high magnetic field that slows down convection that would normally bring hot material to the sun's surface. Consequentially, sunspots are cooler in temperature than the surrounding area (called the photosphere). The image you have is a close-up picture of some of the sun's sunspots, taken with the Swedish 1-m Solar Telescope on the Canary Island La Palma in 2002. The temperature of the sunspots with respect to the photosphere is related to the darkness of the sunspots with respect to the bright photosphere.

Your task is to come up with a way to digitize this image that transmits sufficient information for the temperature of the sunspots with respect to the photosphere to be measured. Think of it as designing an instrument to measure and record images of the sun, with the goal of measuring the sunspot temperature. Do this by encoding this image of the sun in a way that allows another group to reconstruct the image towards the goal of measuring the temperature of the sunspots.

Constraints:
Time: 1 hour
Materials: Those in this room, or you may ask your facilitators if you have a specific supply request. Additionally, you have to work within a budget constraint. The cost of your image can be calculated as:

C = A*nbrt*nsam + B*(nchar - nsam)
where
C = total cost
A = cost per brightness level
B = cost per character
nbrt = number of brightness levels (if applicable)
nsam = number of photometer samples (if applicable)
nchar = total number of characters used to encode your image

You are free to design your image file format however you'd like, given the following constraints:
Budget = $1000
A = $2
B = $1
Maximum number of brightness levels = 12

Image: Full moon (S)

Overview: You have an image. By the end of today's investigation, you will have made an "image file" of your picture. On Thursday you will pass your image file to another group, who will draw it without seeing the image. This is similar to the "Flags" starter, but using written communication instead of spoken communication.

Overall scientific goal: Relief topography (elevation) of the moon
Intermediate step: Mapping maria and terrae
Description:

You are a member of an engineering team. Your team is working on a project to create a map of relief topography (elevation) of the moon. As a first-order approximation, the darker areas (*maria*, or "seas") are lower in elevation, and the lighter-colored areas (*terrae*, or "highlands") are higher in elevation. This is due to the fact that the lower-elevation areas were filled with volcanic lava which then cooled, leaving behind darker-colored basalt rock. The image you have of the near side of the moon was taken with the Galileo robotic spacecraft in December 1992. A photograph of the moon is an image of reflected light across the moon's surface.

Your task is to come up with a way to digitize this image that transmits sufficient information for the maria and terrae to be mapped. Think of it as designing an instrument to measure and record images of the moon, with the goal of mapping the topography. Do this by encoding this image of the moon in a way that allows another group to reconstruct the image towards the goal of mapping the topography of the moon.

Constraints:
Time: 1 hour
Materials: Those in this room, or you may ask your facilitators if you have a specific supply request.

Additionally, you have to work within a budget constraint. The cost of your image can be calculated as:

C = A*nbrt*nsam + B*(nchar - nsam)
where
C = total cost
A = cost per brightness level
B = cost per character
nbrt = number of brightness levels (if applicable)
nsam = number of photometer samples (if applicable)
nchar = total number of characters used to encode your image

You are free to design your image file format however you'd like, given the following constraints:
Budget = $1000
A = $2
B = $1
Maximum number of brightness levels = 12

Image: Full moon (C)

Overview: You have an image. By the end of today's investigation, you will have made an "image file" of your picture. On Thursday you will pass your image file to another group, who will draw it without seeing the image. This is similar to the "Flags" starter, but using written communication instead of spoken communication.

Overall scientific goal: Temperature of different surface rock on moon
Intermediate step: Albedo of different surface rock on moon
Description:

You are a member of an engineering team. Your team is working on a project to study the temperature of different surface rock on the moon. If sunlight falls on the rock with the same intensity and angle, then darker rock will have a higher temperature. Therefore, temperature of the rock is related to its brightness, or *albedo*. Albedo is the fraction of light reflected by an object (Albedo = Amount of Reflected Light / Amount of Incident Light). The image you have of the near side of the moon was taken with the Galileo robotic spacecraft in December 1992. A photograph of the moon is an image of reflected light across the moon's surface.

Your task is to come up with a way to digitize this image that transmits sufficient information for the albedo of the moon to be measured. Think of it as designing an instrument to measure and record images of the moon, with the goal of measuring the temperature. Do this by encoding this image of the moon in a way that allows another group to reconstruct the image towards the goal of measuring the albedo of the moon.

Constraints:
Time: 1 hour
Materials: Those in this room, or you may ask your facilitators if you have a specific supply request.
Additionally, you have to work within a budget constraint. The cost of your image can be calculated as:

C = A*nbrt*nsam + B*(nchar - nsam)
where
C = total cost
A = cost per brightness level
B = cost per character
nbrt = number of brightness levels (if applicable)
nsam = number of photometer samples (if applicable)
nchar = total number of characters used to encode your image

You are free to design your image file format however you'd like, given the following constraints:
Budget = $1000
A = $2
B = $1
Maximum number of brightness levels = 12

Image: Jupiter (S)

Overview: You have an image. By the end of today's investigation, you will have made an "image file" of your picture. On Thursday you will pass your image file to another group, who will draw it without seeing the image. This is similar to the "Flags" starter, but using written communication instead of spoken communication.

Overall scientific goal: Rotation period of Jupiter
Intermediate step: Mapping locations of cloud features
Description:
You are a member of an engineering team. Your team is working on a project to study the rotation period of Jupiter. The planet's visible surface consists of clouds at different altitudes. These clouds are rotating in different rates and directions around Jupiter: some eastward, some westward. Meanwhile, the planet as a whole is rotating, more rapidly than the clouds' speeds. The image you have of Jupiter was taken by the Cassini robotic spacecraft in December 2000. One way to measure the rotation period of Jupiter is to measure the locations of some prominent cloud features at different times, then take the average to be the rotation period.
Your task is to come up with a way to digitize this image that transmits sufficient information for the rotation rate of Jupiter to be measured. Think of it as designing an instrument to measure and record images of Jupiter, with the goal of measuring the rotation rate. Do this by encoding this image of Jupiter in a way that allows another group to reconstruct the image towards the goal of mapping the locations of cloud features.

Constraints:
Time: 1 hour
Materials: Those in this room, or you may ask your facilitators if you have a specific supply request.
Additionally, you have to work within a budget constraint. The cost of your image can be calculated as:

C = A*nbrt*nsam + B*(nchar - nsam)
where
C = total cost
A = cost per brightness level
B = cost per character
nbrt = number of brightness levels (if applicable)
nsam = number of photometer samples (if applicable)
nchar = total number of characters used to encode your image

You are free to design your image file format however you'd like, given the following constraints:
Budget = $1000
A = $2
B = $1
Maximum number of brightness levels = 12

Image: Jupiter (C)

Overview: You have an image. By the end of today's investigation, you will have made an "image file" of your picture. On Thursday you will pass your image file to another group, who will draw it without seeing the image. This is similar to the "Flags" starter, but using written communication instead of spoken communication.

Overall scientific goal: Height of cloud layers
Intermediate step: Brightness/darkness of cloud layers
Description:

You are a member of an engineering team. Your team is working on a project to study the height of cloud layers on Jupiter. The lighter-colored bands are called *zones* and the darker bands are called *belts*. The zones are colder and are likely gas that has ascended to higher altitudes. The belts are warmer and are likely gas that has descended to lower altitudes. The image you have of Jupiter was taken by the Cassini robotic spacecraft in December 2000. The brightness and darkness of the cloud layers can be used to determine the high and low altitude clouds.

Your task is to come up with a way to digitize this image that transmits sufficient information for the brightness of the clouds to be measured. Think of it as designing an instrument to measure and record images of Jupiter, with the goal of measuring the relative heights of the cloud layers. Do this by encoding this image of Jupiter in a way that allows another group to reconstruct the image towards the goal of measuring the brightness of the cloud layers.

Constraints:
Time: 1 hour
Materials: Those in this room, or you may ask your facilitators if you have a specific supply request.
Additionally, you have to work within a budget constraint. The cost of your image can be calculated as:

C = A*nbrt*nsam + B*(nchar - nsam)
where
C = total cost
A = cost per brightness level
B = cost per character
nbrt = number of brightness levels (if applicable)
nsam = number of photometer samples (if applicable)
nchar = total number of characters used to encode your image

You are free to design your image file format however you'd like, given the following constraints:
Budget = $1000
A = $2
B = $1
Maximum number of brightness levels = 12

Image: Saturn (S)

Overview: You have an image. By the end of today's investigation, you will have made an "image file" of your picture. On Thursday you will pass your image file to another group, who will draw it without seeing the image. This is similar to the "Flags" starter, but using written communication instead of spoken communication.

Overall scientific goal: Studying ring structure of Saturn
Intermediate step: Mapping rings of Saturn
Description:
You are a member of an engineering team. Your team is working on a project to study the ring structure of Saturn. The ring structure (locations, gap size, gap locations) is set somewhat by Saturn's moons, and therefore studying the rings is important for understanding dynamics of the moons. The image you have of Saturn was taken by the Cassini robotic spacecraft in May 2007. The rings are visible due to reflected light from the sun.
Your task is to come up with a way to digitize this image that transmits sufficient information for the ring structure of Saturn to be mapped. Think of it as designing an instrument to measure and record images of Saturn's rings, with the goal of studying the structure. Do this by encoding this image of Saturn in a way that allows another group to reconstruct the image towards the goal of mapping the ring structure.

Constraints:
Time: 1 hour
Materials: Those in this room, or you may ask your facilitators if you have a specific supply request.
Additionally, you have to work within a budget constraint. The cost of your image can be calculated as:

C = A*nbrt*nsam + B*(nchar - nsam)
where
C = total cost
A = cost per brightness level
B = cost per character
nbrt = number of brightness levels (if applicable)
nsam = number of photometer samples (if applicable)
nchar = total number of characters used to encode your image

You are free to design your image file format however you'd like, given the following constraints:
Budget = $1000
A = $2
B = $1
Maximum number of brightness levels = 12

Image: Saturn (C)

Overview: You have an image. By the end of today's investigation, you will have made an "image file" of your picture. On Thursday you will pass your image file to another group, who will draw it without seeing the image. This is similar to the "Flags" starter, but using written communication instead of spoken communication.

Overall scientific goal: Chemical composition of Saturn's rings and atmosphere
Intermediate step: Albedo of rings and atmosphere of Saturn
Description:
You are a member of an engineering team. Your team is working on a project to study the composition of Saturn's rings and atmosphere. The brightness, or *albedo*, can be measured to help study composition. Albedo is the fraction of light reflected by an object (Albedo = Amount of Reflected Light / Amount of Incident Light). The image you have of Saturn was taken by the Cassini robotic spacecraft in May 2007. Different chemical species have different albedos; therefore, the albedo can be used as a first approximation for composition.

Your task is to come up with a way to digitize this image that transmits sufficient information for the albedo of the rings and atmosphere of Saturn to be measured. Think of it as designing an instrument to measure and record images of Saturn, with the goal of measuring the chemical composition. Do this by encoding this image of Saturn in a way that allows another group to reconstruct the image towards the goal of measuring the albedo.

Constraints:
Time: 1 hour
Materials: Those in this room, or you may ask your facilitators if you have a specific supply request.
Additionally, you have to work within a budget constraint. The cost of your image can be calculated as:

C = A*nbrt*nsam + B*(nchar - nsam)
where
C = total cost
A = cost per brightness level
B = cost per character
nbrt = number of brightness levels (if applicable)
nsam = number of photometer samples (if applicable)
nchar = total number of characters used to encode your image

You are free to design your image file format however you'd like, given the following constraints:
Budget = $1000
A = $2
B = $1
Maximum number of brightness levels = 12

Image: False-color Moon (C)

Overview: You have an image. By the end of today's investigation, you will have made an "image file" of your picture. On Thursday you will pass your image file to another group, who will draw it without seeing the image. This is similar to the "Flags" starter, but using written communication instead of spoken communication.

Overall scientific goal: Chemical composition of rocks on the moon
Intermediate step: Colors of moon rocks in a false-color image
Description:
You are a member of an engineering team. Your team is working on a project to study the chemical composition of the moon's rocks. The moon's surface rock contains different amounts of elements such as titanium and iron. The image you have of the moon was taken by the Galileo robotic spacecraft in 1992. It is a *false-color image*, meaning the colors are not true-to-life, but they are created in imaging software from data taken in 3 different color filters. The color filters use the fact that different rock minerals reflect light differently. Blue areas have enhanced titanium while orange and purple areas are relatively depleted in titanium and iron.

Your task is to come up with a way to digitize this image that transmits sufficient information for the chemical composition of rocks on the moon to be measured. Think of it as designing an instrument to measure and record false-color images of the moon, with the goal of measuring the chemical composition of the rocks. Do this by encoding this image of the moon in a way that allows another group to reconstruct the image towards the goal of determining the chemical compositions of the rocks. You will be transmitting the false colors, not true colors.

Constraints:
Time: 1 hour
Materials: Those in this room, or you may ask your facilitators if you have a specific supply request. Additionally, you have to work within a budget constraint. The cost of your image can be calculated as:

C = A*nbrt*nsam + B*(nchar - ncol*nsam)
where
C = total cost
A = cost per brightness level
B = cost per character
nbrt = number of brightness levels (if applicable)
ncol = number of colors (if applicable)
nsam = number of photometer samples (if applicable)
nchar = total number of characters used to encode your image

You are free to design your image file format however you'd like, given the following constraints:
Budget = $1000
A = $2
B = $1
Maximum number of brightness levels = 12

Image: Full-color Jupiter (C)

Overview: You have an image. By the end of today's investigation, you will have made an "image file" of your picture. On Thursday you will pass your image file to another group, who will draw it without seeing the image. This is similar to the "Flags" starter, but using written communication instead of spoken communication.

Overall scientific goal: Chemical composition of Jupiter's atmosphere
Intermediate step: Colors of cloud features
Description:

You are a member of an engineering team. Your team is working on a project to study the chemical composition of Jupiter's atmosphere. The planet's visible surface consists of clouds of different color, altitude, and chemical composition. The image you have of Jupiter was taken by the Cassini robotic spacecraft in December 2000. Color gives clues about the chemical composition of the clouds.

Your task is to come up with a way to digitize this image that transmits sufficient information for the cloud colors of Jupiter to be measured. Think of it as designing an instrument to measure and record images of Jupiter, with the goal of measuring the chemical composition of the clouds. Do this by encoding this image of Jupiter in a way that allows another group to reconstruct the image towards the goal of determining the chemical compositions of cloud features.

Constraints:
Time: 1 hour
Materials: Those in this room, or you may ask your facilitators if you have a specific supply request.
Additionally, you have to work within a budget constraint. The cost of your image can be calculated as:

C = A*nbrt*nsam + B*(nchar - ncol*nsam)
where
C = total cost
A = cost per brightness level
B = cost per character
nbrt = number of brightness levels (if applicable)
ncol = number of colors (if applicable)
nsam = number of photometer samples (if applicable)
nchar = total number of characters used to encode your image

You are free to design your image file format however you'd like, given the following constraints:
Budget = $1000
A = $2
B = $1
Maximum number of brightness levels = 12

ETRO 102 – Instrumentation for Engineering Technology
Digital Image Files: Post-activity Feedback Form **Akamai Workforce Initiative**

1. Feedback on this week's activities

Please rate the various components of the Digital Images activity, and provide any comments next to your rating: this will help us make a more engaging and informative activity for future students. If you did not participate in an activity, just write "N/A".

1	2	3	4	5
not valuable at all	minimally valuable	neutral	fairly valuable	very valuable

Activity	*Rating*	*Comments about your rating (optional)*
a. Starter activities (flags, moon pictures, photometers, happy faces)	X 1	
b. Focused investigation: measuring and encoding your image	X 1	Needs a computer...
c. Homework assignment: image file creation and reflection paper	X 1	Useless
d. Image decoding: reconstructing another group's image.	V 5	Good excercise
e. Discussion and group sharing	V 5	
f. Computer activities	X 1	
g. Synthesis discussion: bringing it all together	3	

2. What are a few important or valuable things you learned in this activity?

Nothing. :(~ That translator was offensi

3. What new questions do you have, or ideas you want to further explore?

↑ :(

ETRO 102 – Instrumentation for Engineering Technology
Digital Image Files: Post-activity Feedback Form **Akamai Workforce Initiative**

1. Feedback on this week's activities

Please rate the various components of the Digital Images activity, and provide any comments next to your rating: this will help us make a more engaging and informative activity for future students. If you did not participate in an activity, just write "N/A".

1	2	3	4	5
not valuable at all	minimally valuable	neutral	fairly valuable	very valuable

Activity	*Rating*	*Comments about your rating (optional)*
a. Starter activities (flags, moon pictures, photometers, happy faces)	3	needed more information to understand stations as could be used in "b"
b. Focused investigation: measuring and encoding your image	3	trouble understanding goal & didn't have knowledge (☺ coding)
c. Homework assignment: image file creation and reflection paper	4-5	helped to process day & fit it all together
d. Image decoding: reconstructing another group's image.	4-5	"
e. Discussion and group sharing	4-5	"
f. Computer activities		
g. Synthesis discussion: bringing it all together	4	icing on the cake

2. What are a few important or valuable things you learned in this activity?

3. What new questions do you have, or ideas you want to further explore?

ETRO 102 – Instrumentation for Engineering Technology
Digital Image Files: Post-activity Feedback Form **Akamai Workforce Initiative**

1. Feedback on this week's activities

Please rate the various components of the Digital Images activity, and provide any comments next to your rating: this will help us make a more engaging and informative activity for future students. If you did not participate in an activity, just write "N/A".

1	2	3	4	5
not valuable at all	minimally valuable	neutral	fairly valuable	very valuable

Activity	*Rating*	*Comments about your rating (optional)*
a. Starter activities (flags, moon pictures, photometers, happy faces)	5	It would of helped to know more about the project when doing this Activity
b. Focused investigation: measuring and encoding your image	3	Was totally lost during this activity
c. Homework assignment: image file creation and reflection paper		N/A
d. Image decoding: reconstructing another group's image.	3	Was Interesting
e. Discussion and group sharing	3-4	Was cool
f. Computer activities		N/A
g. Synthesis discussion: bringing it all together	4	

2. What are a few important or valuable things you learned in this activity?

Learned about the detailsof Pixels

3. What new questions do you have, or ideas you want to further explore?

ETRO 102 – Instrumentation for Engineering Technology
Digital Image Files: Post-activity Feedback Form **Akamai Workforce Initiative**

1. Feedback on this week's activities

Please rate the various components of the Digital Images activity, and provide any comments next to your rating: this will help us make a more engaging and informative activity for future students. If you did not participate in an activity, just write "N/A".

1	2	3	4	5
not valuable at all	minimally valuable	neutral	fairly valuable	very valuable

Activity	*Rating*	*Comments about your rating (optional)*
a. Starter activities (flags, moon pictures, photometers, happy faces)	5	These were great at getting us thinking about the concepts
b. Focused investigation: measuring and encoding your image	5	This was a lot of fun and got us to use scientific and engineering methods
c. Homework assignment: image file creation and reflection paper	4	This was tough but I learned a lot about PGM format
d. Image decoding: reconstructing another group's image.	4	This was also a lot of fun. It let us see how someone else met a similar challenge
e. Discussion and group sharing	3	
f. Computer activities	3	These were fun though I had chosen this format for encoding my own image, so I was already quite familiar with it
g. Synthesis discussion: bringing it all together	5	This was quite helpful in bringing all the info together. I learn better by listening, so I picked up more info here than any other part.

2. What are a few important or valuable things you learned in this activity?

I learned the specifics of some file formats. I learned about making tradeoffs and about how to make the decisions needed in the tradeoff.

3. What new questions do you have, or ideas you want to further explore?

I'd like to learn about other formats. I'd like another crack at encoding the image.

1. Feedback on this week's activities

Please rate the various components of the Digital Images activity, and provide any comments next to your rating: this will help us make a more engaging and informative activity for future students. If you did not participate in an activity, just write "N/A".

1	2	3	4	5
not valuable at all	minimally valuable	neutral	fairly valuable	very valuable

Activity	*Rating*	*Comments about your rating (optional)*
a. Starter activities (flags, moon pictures, photometers, happy faces)	3	
b. Focused investigation: measuring and encoding your image	4	
c. Homework assignment: image file creation and reflection paper	4	
d. Image decoding: reconstructing another group's image.	5	
e. Discussion and group sharing	5	
f. Computer activities	3	
g. Synthesis discussion: bringing it all together	4	

2. What are a few important or valuable things you learned in this activity?

I have learned the fundamental principles of image encoding..

I have learned there are many ways to transmit & communicate the images we are trying to encode/decode.

3. What new questions do you have, or ideas you want to further explore?

More on image formatting and compression.

Fun Experiment!

1. Feedback on this week's activities

Please rate the various components of the Digital Images activity, and provide any comments next to your rating: this will help us make a more engaging and informative activity for future students. If you did not participate in an activity, just write "N/A".

1	2	3	4	5
not valuable at all	minimally valuable	neutral	fairly valuable	very valuable

Activity	*Rating*	*Comments about your rating (optional)*
a. Starter activities (flags, moon pictures, photometers, happy faces)	4	
b. Focused investigation: measuring and encoding your image	5	
c. Homework assignment: image file creation and reflection paper	3	
d. Image decoding: reconstructing another group's image.	4	
e. Discussion and group sharing	5	
f. Computer activities	5	
g. Synthesis discussion: bringing it all together	4	

2. What are a few important or valuable things you learned in this activity?

What I have learned in this activity was learning how to incoding to encoding an image.

3. What new questions do you have, or ideas you want to further explore?

I would like to learn more about incoding and encoding an image or images.

ETRO 102 – Instrumentation for Engineering Technology
Digital Image Files: Post-activity Feedback Form **Akamai Workforce Initiative**

1. Feedback on this week's activities

Please rate the various components of the Digital Images activity, and provide any comments next to your rating: this will help us make a more engaging and informative activity for future students. If you did not participate in an activity, just write "N/A".

1	2	3	4	5
not valuable at all	minimally valuable	neutral	fairly valuable	very valuable

Activity	*Rating*	*Comments about your rating (optional)*
a. Starter activities (flags, moon pictures, photometers, happy faces)	2	
b. Focused investigation: measuring and encoding your image	4	
c. Homework assignment: image file creation and reflection paper	3	
d. Image decoding: reconstructing another group's image.	4	
e. Discussion and group sharing	~~4~~ 3	
f. Computer activities	3	
g. Synthesis discussion: bringing it all together	5	

2. What are a few important or valuable things you learned in this activity?

the protocol of decoding the data is very important

3. What new questions do you have, or ideas you want to further explore?

ETRO 102 – Instrumentation for Engineering Technology
Digital Image Files: Post-activity Feedback Form **Akamai Workforce Initiative**

1. Feedback on this week's activities

Please rate the various components of the Digital Images activity, and provide any comments next to your rating: this will help us make a more engaging and informative activity for future students. If you did not participate in an activity, just write "N/A".

1	2	3	4	5
not valuable at all	minimally valuable	neutral	fairly valuable	very valuable

Activity	*Rating*	*Comments about your rating (optional)*
a. Starter activities (flags, moon pictures, photometers, happy faces)	4	
b. Focused investigation: measuring and encoding your image	4	It was kind of confusing
c. Homework assignment: image file creation and reflection paper	4	
d. Image decoding: reconstructing another group's image.	5	
e. Discussion and group sharing	5	I learned a lot from this part
f. Computer activities	5	Didn't really get to do it
g. Synthesis discussion: bringing it all together	5	Nice wrap up

2. What are a few important or valuable things you learned in this activity?

Pictures are really just numbers
The decoding isn't as hard as I first ~~as~~ thought, if we have the code

3. What new questions do you have, or ideas you want to further explore?

How differently an image can be changed.
Making an image w/ numbers

* It all seemed a bit unorganized, but I like the idea

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1	2	3	4	5
not valuable at all	minimally valuable	neutral	fairly valuable	very valuable

Activity	*Rating*	*Comments about your rating (optional)*
a. Starter activities (flags, moon pictures, photometers, happy faces)	5	
b. Focused investigation: measuring and encoding your image	4	
c. Homework assignment: image file creation and reflection paper	1	
d. Image decoding: reconstructing another group's image.	5	
e. Discussion and group sharing	5	
f. Computer activities	1	
g. Synthesis discussion: bringing it all together	5	

2. What are a few important or valuable things you learned in this activity?

COMMUNICATION

3. What new questions do you have, or ideas you want to further explore?

HOW TO MAKE MONEY

ETRO 102 – Instrumentation for Engineering Technology
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1	2	3	4	5
not valuable at all	minimally valuable	neutral	fairly valuable	very valuable

Activity	*Rating*	*Comments about your rating (optional)*
a. Starter activities (flags, moon pictures, photometers, happy faces)	4	
b. Focused investigation: measuring and encoding your image	2	
c. Homework assignment: image file creation and reflection paper	2	
d. Image decoding: reconstructing another group's image.	3	
e. Discussion and group sharing	5	
f. Computer activities	4	
g. Synthesis discussion: bringing it all together	5	

2. What are a few important or valuable things you learned in this activity?

Communication + team work is needed.

3. What new questions do you have, or ideas you want to further explore?

ETRO 102 – Instrumentation for Engineering Technology	
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1	2	3	4	5
not valuable at all	minimally valuable	neutral	fairly valuable	very valuable

Activity	*Rating*	*Comments about your rating (optional)*
a. Starter activities (flags, moon pictures, photometers, happy faces)	2	I knew what you were trying to do
b. Focused investigation: measuring and encoding your image	1	waste of my time
c. Homework assignment: image file creation and reflection paper	1	waste... I never turned it in
d. Image decoding: reconstructing another group's image.	N/A	not there
e. Discussion and group sharing	N/A	✓
f. Computer activities	N/A	
g. Synthesis discussion: bringing it all together	N/A	

2. What are a few important or valuable things you learned in this activity?

N/A

3. What new questions do you have, or ideas you want to further explore?

N/A

1. Feedback on this week's activities

Please rate the various components of the Digital Images activity, and provide any comments next to your rating: this will help us make a more engaging and informative activity for future students. If you did not participate in an activity, just write "N/A".

1	2	3	4	5
not valuable at all	minimally valuable	neutral	fairly valuable	very valuable

Activity	*Rating*	*Comments about your rating (optional)*
a. Starter activities (flags, moon pictures, photometers, happy faces)	5	It was helpful to observe the basic elements of the activity.
b. Focused investigation: measuring and encoding your image	5	
c. Homework assignment: image file creation and reflection paper	5	
d. Image decoding: reconstructing another group's image.	5	
e. Discussion and group sharing	5	
f. Computer activities	5	
g. Synthesis discussion: bringing it all together	5	Doing the synthesis help better the understanding of the whole activity.

2. What are a few important or valuable things you learned in this activity?

Some important things I learned in the activity was knowing about pixels, grayscales, formats, and using a photometer to create an image of an object.

3. What new questions do you have, or ideas you want to further explore?

None

1. Feedback on this week's activities

Please rate the various components of the Digital Images activity, and provide any comments next to your rating: this will help us make a more engaging and informative activity for future students. If you did not participate in an activity, just write "N/A".

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not valuable at all	minimally valuable	neutral	fairly valuable	very valuable

Activity	*Rating*	*Comments about your rating (optional)*
a. Starter activities (flags, moon pictures, photometers, happy faces)	4	
b. Focused investigation: measuring and encoding your image	4	
c. Homework assignment: image file creation and reflection paper	4	
d. Image decoding: reconstructing another group's image.	4	
e. Discussion and group sharing	4	
f. Computer activities	4	
g. Synthesis discussion: bringing it all together	4	

2. What are a few important or valuable things you learned in this activity?

LEARNED MORE ABOUT HOW ALOT OF OTHER THINGS I USE IN LIFE WORK

3. What new questions do you have, or ideas you want to further explore?

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not valuable at all	minimally valuable	neutral	fairly valuable	very valuable

Activity	*Rating*	*Comments about your rating (optional)*
a. Starter activities (flags, moon pictures, photometers, happy faces)	4	
b. Focused investigation: measuring and encoding your image	4	
c. Homework assignment: image file creation and reflection paper	4	
d. Image decoding: reconstructing another group's image.	5	
e. Discussion and group sharing	5	
f. Computer activities	4	
g. Synthesis discussion: bringing it all together	4	

2. What are a few important or valuable things you learned in this activity?

Too much to tell

3. What new questions do you have, or ideas you want to further explore?

None

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b. Focused investigation: measuring and encoding your image	5	
c. Homework assignment: image file creation and reflection paper	5	
d. Image decoding: reconstructing another group's image.	5	
e. Discussion and group sharing	4	
f. Computer activities	4	
g. Synthesis discussion: bringing it all together	4	

2. What are a few important or valuable things you learned in this activity?

Encoding & Decoding

3. What new questions do you have, or ideas you want to further explore?

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Activity	*Rating*	*Comments about your rating (optional)*
a. Starter activities (flags, moon pictures, photometers, happy faces)	5	
b. Focused investigation: measuring and encoding your image	5	
c. Homework assignment: image file creation and reflection paper	5	
d. Image decoding: reconstructing another group's image.	5	
e. Discussion and group sharing	5	
f. Computer activities	5	
g. Synthesis discussion: bringing it all together	5	

2. What are a few important or valuable things you learned in this activity?

I have learn about image formats

3. What new questions do you have, or ideas you want to further explore?

N/A

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not valuable at all	minimally valuable	neutral	fairly valuable	very valuable

Activity	*Rating*	*Comments about your rating (optional)*
a. Starter activities (flags, moon pictures, photometers, happy faces)	N/A	
b. Focused investigation: measuring and encoding your image	N/A	
c. Homework assignment: image file creation and reflection paper	N/A	
d. Image decoding: reconstructing another group's image.	3	
e. Discussion and group sharing	3	
f. Computer activities	4	
g. Synthesis discussion: bringing it all together	4	

2. What are a few important or valuable things you learned in this activity?

How images are encoded

3. What new questions do you have, or ideas you want to further explore?

More higher level photometer/images things

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b. Focused investigation: measuring and encoding your image	5	
c. Homework assignment: image file creation and reflection paper	5	
d. Image decoding: reconstructing another group's image.	5	
e. Discussion and group sharing	5	
f. Computer activities	5	
g. Synthesis discussion: bringing it all together	5	

2. What are a few important or valuable things you learned in this activity?

Communication
Engineering thought process

3. What new questions do you have, or ideas you want to further explore?

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c. Homework assignment: image file creation and reflection paper	5	
d. Image decoding: reconstructing another group's image.	5	
e. Discussion and group sharing	5	
f. Computer activities	5	
g. Synthesis discussion: bringing it all together	5	

2. What are a few important or valuable things you learned in this activity?

Tradeoffs, time constraints, representing images with #s.

3. What new questions do you have, or ideas you want to further explore?

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c. Homework assignment: image file creation and reflection paper	4	
d. Image decoding: reconstructing another group's image.	5	
e. Discussion and group sharing	5	
f. Computer activities	5	
g. Synthesis discussion: bringing it all together	5	

2. What are a few important or valuable things you learned in this activity?

The measurements of the colors of the image.

3. What new questions do you have, or ideas you want to further explore?

N/A

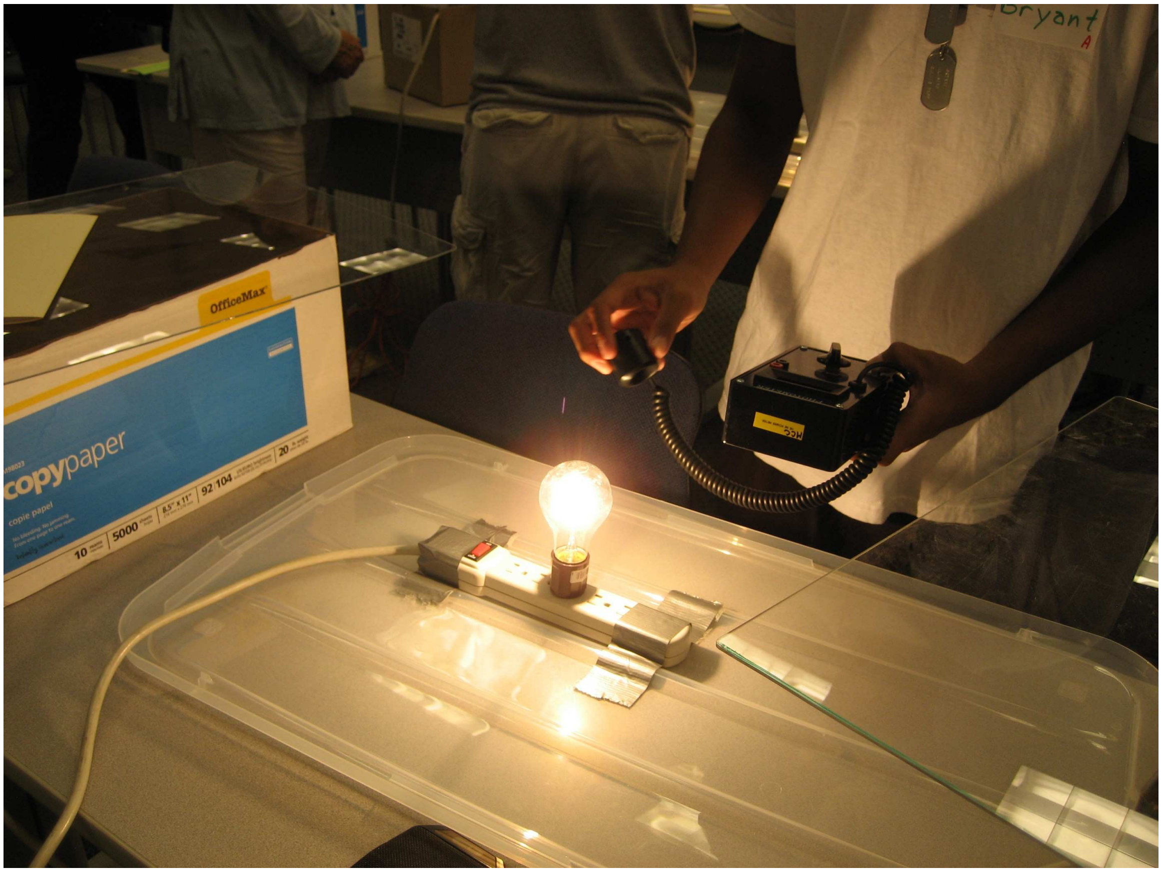
MCC Digital Images: Groups

PUR	A	1	Zach
BLU	A	2	Erica
GRE	A	3	Bryant
PUR	H	4	Christopher
BLU	H	1	Jonathan
GRE	H	2	Lindsay
PUR	K	3	Jesse
BLU	K	4	John
GRE	K	1	Bryan

L	PUR	2	David
L	BLU	3	Viola
L	GRE	4	Ericson
M	PUR	1	Darlynda
M	BLU	2	Lisa
M	GRE	3	Rob
N	PUR	4	Joe
N	BLU	1	Steven
N	GRE	2	Kris

P	PUR	3	Jason
P	BLU	4	Shannon
P	GRE	1	Riley
U	PUR	2	Ryan
U	BLU	3	Yosef
U	GRE	4	April
W	PUR	1	Matthew
W	BLU	2	Almie
E	PUR	3	Brandon
E	GRE	4	Marlene

1,2,3,4: starter groups
A, E, H, K, L, M, N, P, U, W: investigation groups
Purple, BLUE, GREEN: discussion groups at conclusion


Bryant
OfficeMax
copypaper
copie papel


Crayola

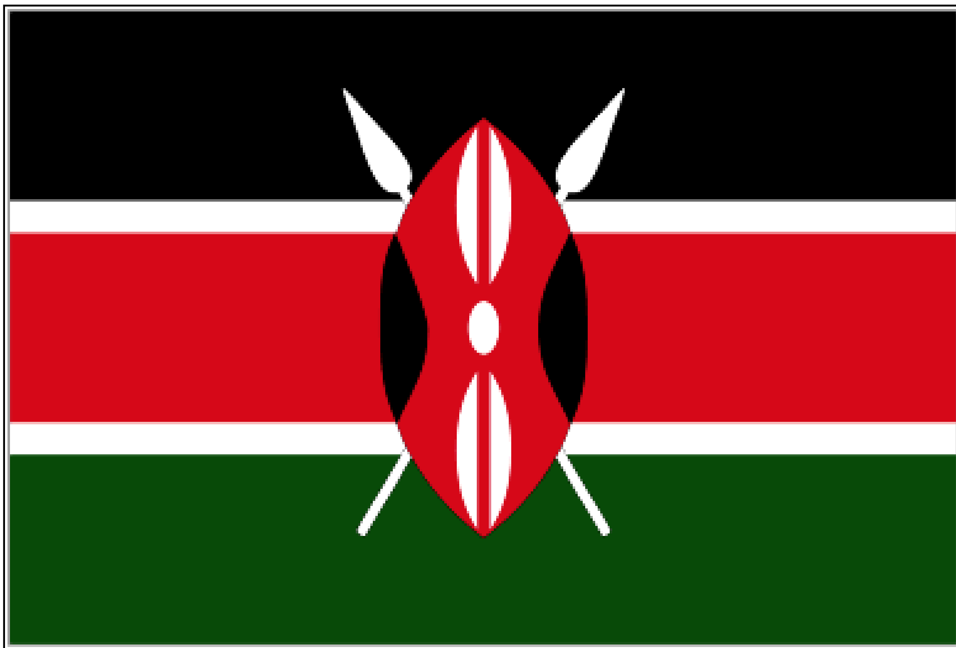

NO
FOOD + DRINKS
ALLOWED
IN STUDIO
LOT NO.
PIECE NO.
1.51 CUBE
EZEKIEL

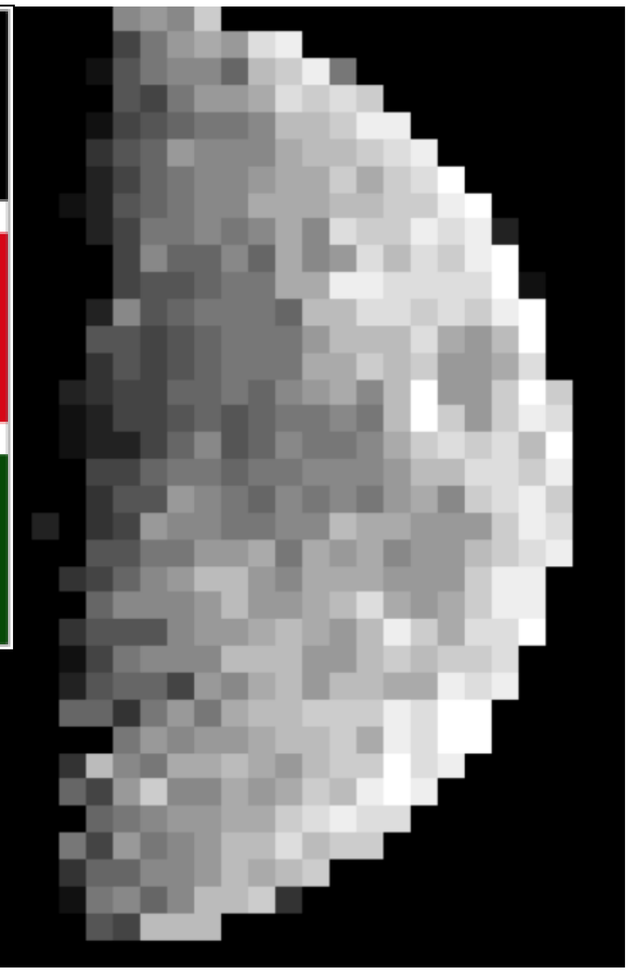

Standards
Evaluating Tradeoffs
Image File Formats

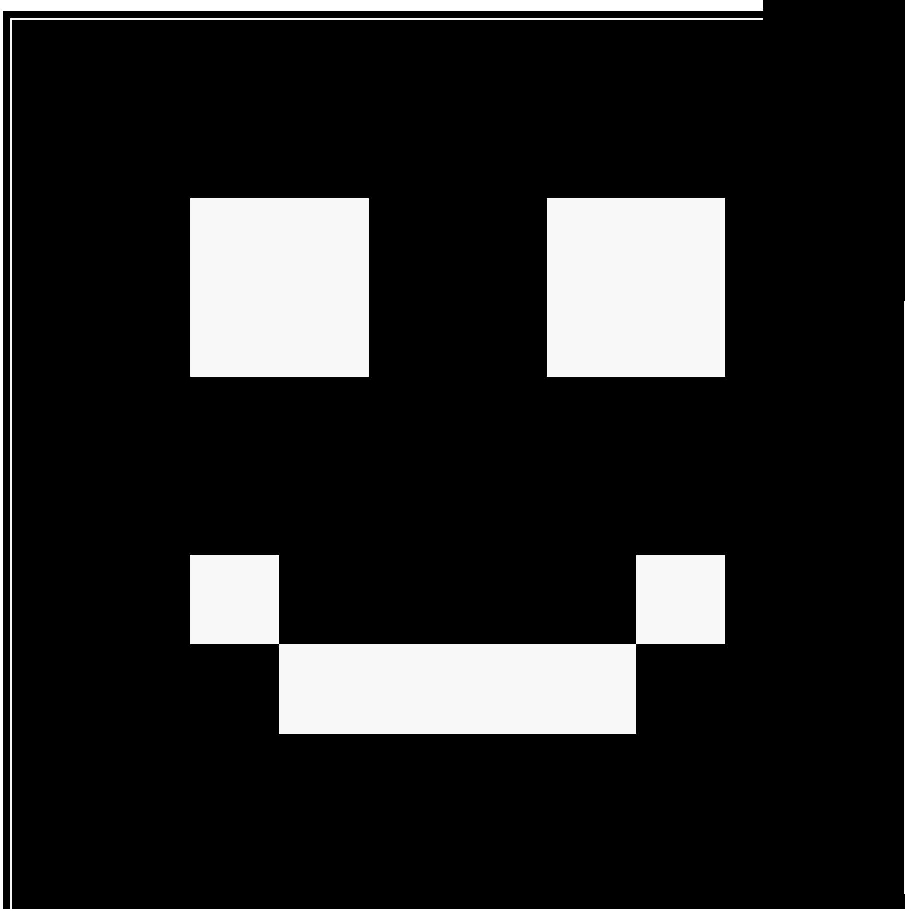

Matthew


April
Full Moon


FuLL MOON
CODE
We used a photometer
Size: 7 x 8
PGM FiLe
Rob







Everyone did a GREAT job!