

Drawing

SEASON 7 – ROUND FIVE



After many unsuccessful business ideas, Lora decided to try some illegal methods of enrichment. Looking at the paintings sold for millions these days, she realized that their counterfeiting should not be particularly difficult. Unfortunately, since her school grades in art weren't great, she knows that she will be unable to cope with this task herself, and so she decided to make a robot to paint for her. Before she starts building the robot, she wants to make sure that good enough software can be made for it, and of course that's your job.

Colors and paintings

A *color* is a triple of integers $\{R, G, B\}$ in the range $[0, 255]$, respectively describing the red, green, and blue color component (RGB format).

The *paintings* the robot will work with are tables $N \times N$ of colors, describing each pixel in the painting. Rows are numbered from 0 to $N-1$ from top to bottom and columns are numbered 0 to $N-1$ from left to right. With (x, y) we denote the pixel on line x and column y .

The robot aims to paint the given painting, starting with a white canvas (a white canvas is a picture $N \times N$ containing only the color $\{255, 255, 255\}$).

Mixing two colors (r_1, g_1, b_1) and (r_2, g_2, b_2) gives the color $(\lfloor \frac{r_1+r_2}{2} \rfloor, \lfloor \frac{g_1+g_2}{2} \rfloor, \lfloor \frac{b_1+b_2}{2} \rfloor)$, i.e. it gives us the arithmetic mean of each color component.

Lora's robot

The robot has a palette containing K colors numbered from 0 to $K-1$, and a space for an *active color*, which is initially white (i.e. $\{255, 255, 255\}$). When it is painting, the robot uses the active color. To change it, the robot can mix it either with a color of the palette or with a color found in the painting it draws.

The robot also has two modes of drawing. If it presses the paintbrush, the robot selects a rectangle and colors it in the active color. If it does not press the paintbrush, the robot selects a rectangle and mixes each pixel with the active color. Because the robot will be small in size, for one operation, the rectangle in which it draws cannot be too large.

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Formally, the robot accepts the following commands:

- “1 p ” – the active color is mixed with color number p in the palette. The resulting color is the new active color.
- “2 x y ” – the active color is mixed with the current color of the pixel (x, y) of the painting the robot has made. The resulting color is the new active color.
- “3 x_1 y_1 x_2 y_2 ” – for each pixel (x, y) such that $x_1 \leq x \leq x_2$ and $y_1 \leq y \leq y_2$, its color becomes equal to the active color.
- “4 x_1 y_1 x_2 y_2 ” – for each pixel (x, y) such that $x_1 \leq x \leq x_2$ and $y_1 \leq y \leq y_2$, its color becomes equal to the mixing of the active color and the current color of the pixel.

Due to the size of the robot, the area of the rectangle in operations 3 and 4 may be at most 200. Formally, the following must be fulfilled: $(x_2 - x_1 + 1) \times (y_2 - y_1 + 1) \leq 200$

Your task is to create a program that, given a goal painting, produces a series of commands such that, after execution by the robot, creates a painting as close as possible to the one requested.

The distance between two colors (r_1, g_1, b_1) and (r_2, g_2, b_2) is equal to $\sqrt{(r_1 - r_2)^2 + (g_1 - g_2)^2 + (b_1 - b_2)^2}$.

The distance between two paintings is the sum of the distances of every two pixels that are in the same position. I.e. for each pixel (x, y) we sum the difference between the pixels in position (x, y) in the first painting and the pixels in position (x, y) in the second painting.

The result of your program on each test is the distance between the two paintings. Your aim is to minimize that distance.

Note: If a command of type 3 or 4 has $x_1 > x_2$ or $y_1 > y_2$, the command has no effect, but will be counted towards the total number of commands.

Input

The first row of the file `drawing.in` consists of two integers **N** and **K** – respectively the size of the goal painting and the number of colors in the palette. Then K rows follow, each of which containing 3 integers, describing the colors in the palette in RGB format. Then 3 tables with N lines and N columns follow - respectively the red, green and blue components of each pixel.

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Output

On the first row of the output file `drawing.out` print one number **C** – the number of commands the robot will execute. In each of the following **C** rows print one command in the aforementioned format, in the order in which they must be executed.

Constraints

- $N = 300$
- $2 \leq K \leq 12$
- **The maximum number of commands is 90 000 !**
- Time limit – 5 seconds
- Memory limit – 256MB

Subtasks

Amount of tests	Additional constraints
20%	$K = 2$ and the colors in the palette are $\{0, 0, 0\}$ and $\{255, 255, 255\}$ (black and white)
other 20%	$K = 5$ and the colors in the palette are $\{0, 0, 0\}$, $\{255, 0, 0\}$, $\{0, 255, 0\}$, $\{0, 0, 255\}$ и $\{255, 255, 255\}$ (black, red, green, blue and black)
other 20%	$K = 2$
other 40%	There are no additional constraints

Testcases

In 20% of the testcases the picture will be generated randomly. For each pixel, 3 random values will be selected in the range $[0, 255]$ with the same probability.

In another 20% of the tests, the picture will be generated again randomly, but with a set of random robot commands starting from a white canvas. The palette used to generate the test will be that given in the test. The robot commands will be between 50,000 and 90,000 in number and will fulfill the limitations described in the task.

The remaining 60% of the tests will be real paintings. The paintings will not necessarily belong to a specific art movement, but it is guaranteed that they will be whole or parts of physically existing paintings.

This ratio of the different ways to generate tests (1:1:3) will be met separately in each subtask as well.

Scoring

You will get 0 points if your output is invalid. Any output that is improperly formatted or sets an invalid command (for example pixels outside the picture) is invalid.

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If your output is valid, you will get $100 \times \left(\frac{\text{minResult}+1}{\text{yourResult}+1}\right)$ the percentage of points provided for that test. We define yourScore as the result obtained after running your program and minScore as the smallest result obtained from one of the participants' programs.

Visualisator

You can use the visualisator provided on the website to visualise the robot's work on the commands given by your solution. More instructions for using the visualisator can also be found on the website.

Sample test

Input (<i>drawing.in</i>)	Output (<i>drawing.out</i>)
3 2	5
200 0 0	1 0
10 230 120	3 0 0 2 1
220 170 190	2 0 2
220 170 190	1 1
220 170 190	4 0 1 2 2
120 150 230	
120 150 230	
120 150 230	
120 140 230	
120 140 230	
120 140 230	

Test explanation

The test given is for illustration only. In real tests we will always have $N = 300$.

Initially the painting that the robot is drawing is white. The active color is white as well. The painting that has to be drawn is:



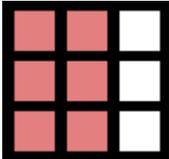
Command "1 0" mixes the active white color with color number 0 from the palette {200, 0, 0} creating a new active color {227, 127, 127}.

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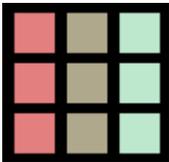
Command “3 0 0 2 1” colors a rectangle in the active color, covering the old colors of the pixels. The new painting of the robot becomes:



Command “2 0 2” mixes the active color {227, 127, 127} with the color of the pixel (0, 2), which is currently white. We get a new active color {241, 191, 191}.

Command “1 1” mixes the active color {241, 191, 191} with color number 1 from the palette {10, 230, 120} resulting in a new active color {125, 210, 155}.

Command “4 0 1 2 2” colors a rectangle by mixing it with the active color. The new and final painting of the robot becomes:



The distance of the respective pixels in the first column is:

$$\sqrt{(227 - 220)^2 + (127 - 120)^2 + (127 - 120)^2} \approx 12.12$$

The distance of the respective pixels in the second column is:

$$\sqrt{(176 - 170)^2 + (168 - 150)^2 + (141 - 140)^2} = 19$$

The distance of the respective pixels in the third column is:

$$\sqrt{(190 - 190)^2 + (232 - 230)^2 + (205 - 230)^2} \approx 25.08$$

Since each column has three pixels, the total distance between the pictures is approximately 168.6 – the result for this output (when actual testing takes places, the result will be calculated considering at least six digits after the decimal point).