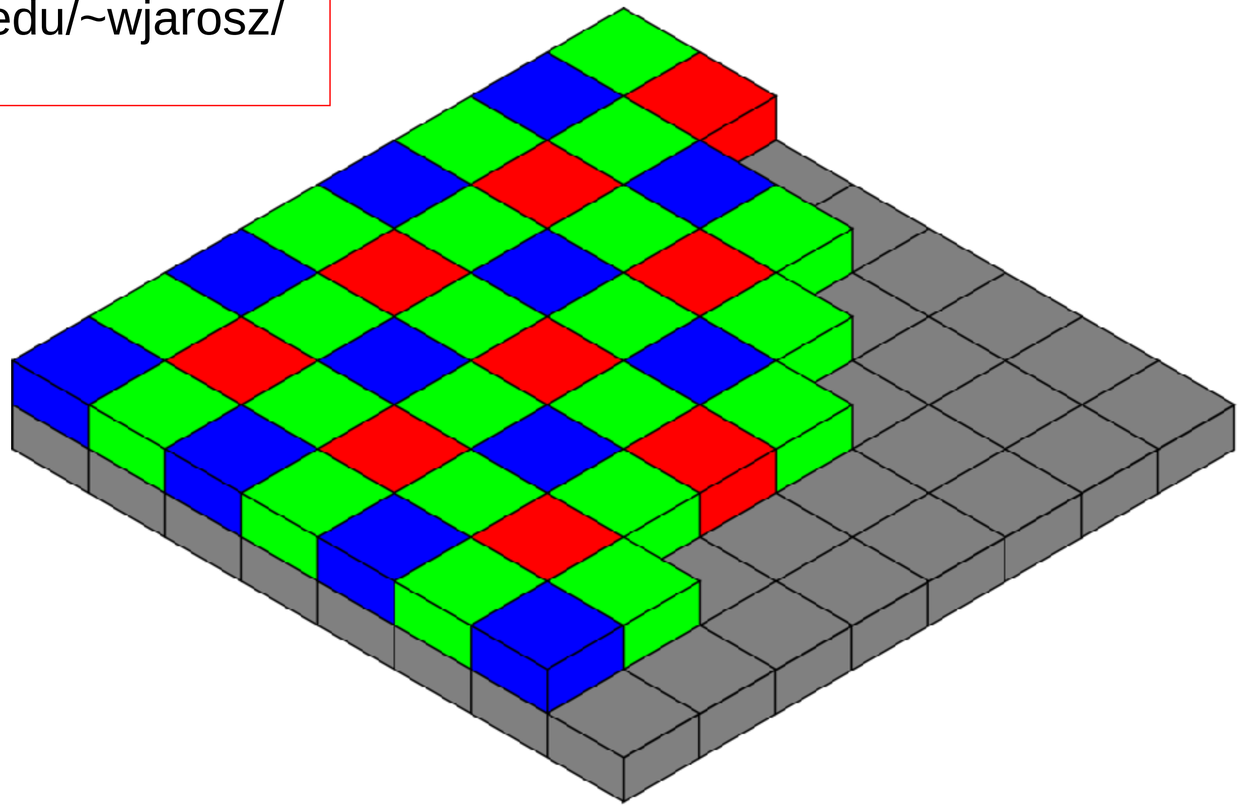
CS 73/273

COMPUTATIONAL PHOTOGRAPHY

https://cs.dartmouth.edu/~wjarosz/
Fall 2020



Sensors & Demosaicing

Wojciech Jarosz
wojciech.k.jarosz@dartmouth.edu

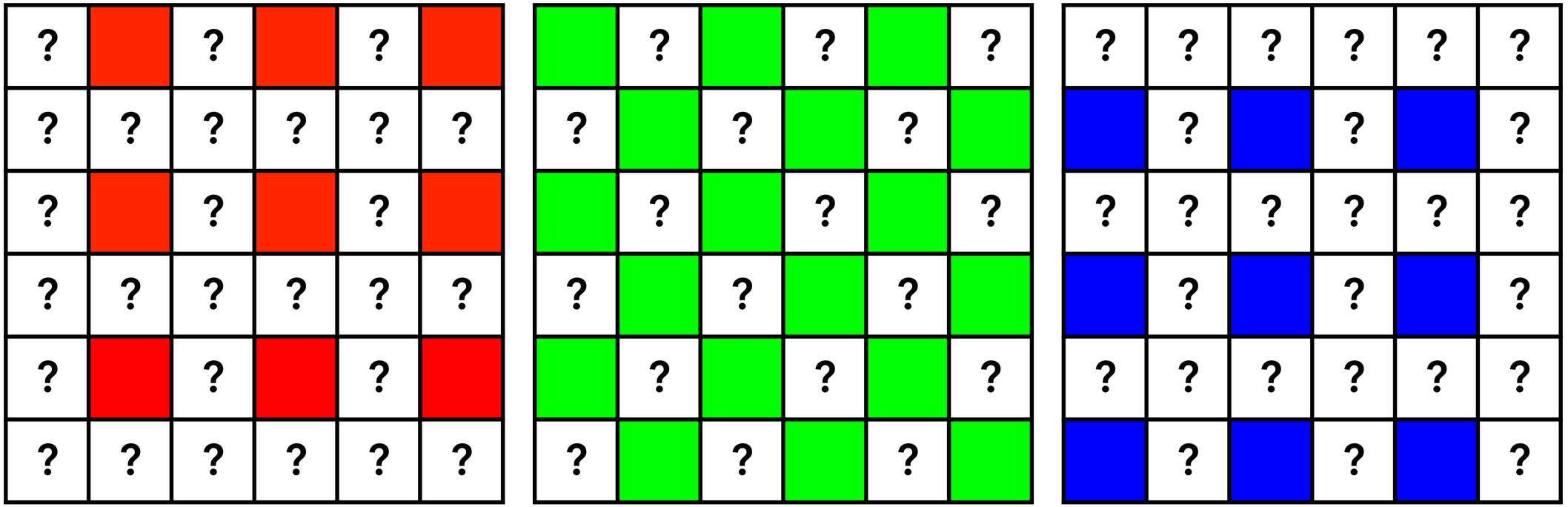
DARTMOUTH
Department of Computer Science

Demosaicing

Demosaicing

Interpolate missing values

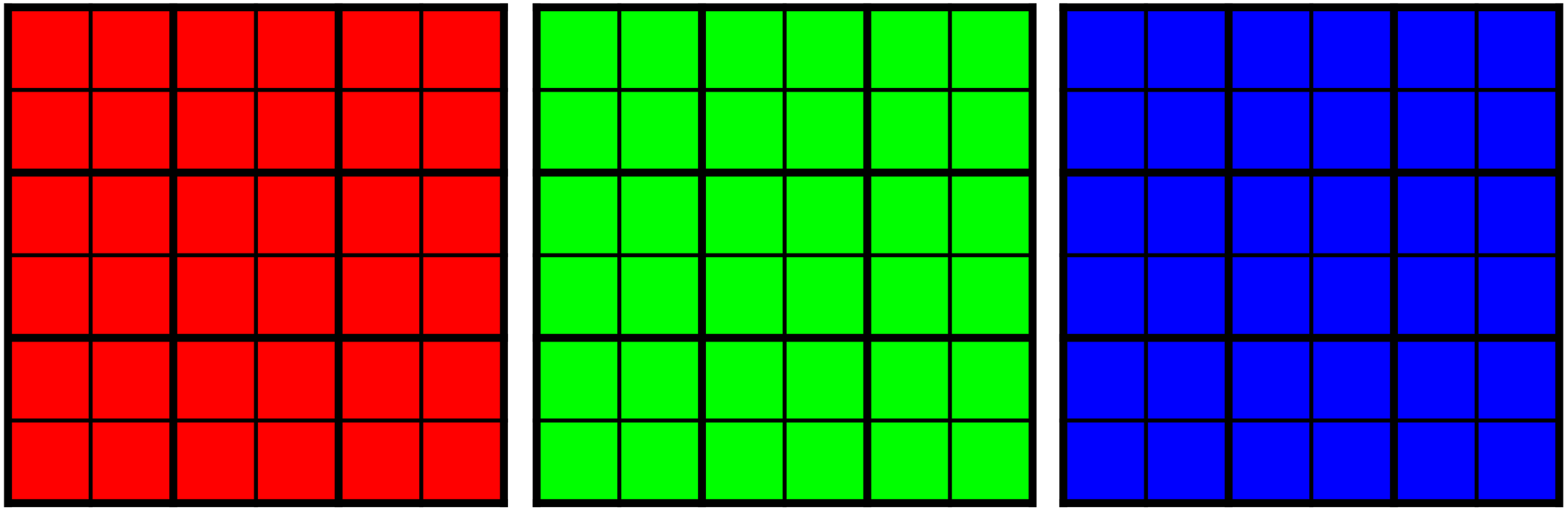
- 2/3 of the full-resolution data will be made up!



Half-resolution demosaicing

Simplest solution: treat each block of 2x2 as a pixel

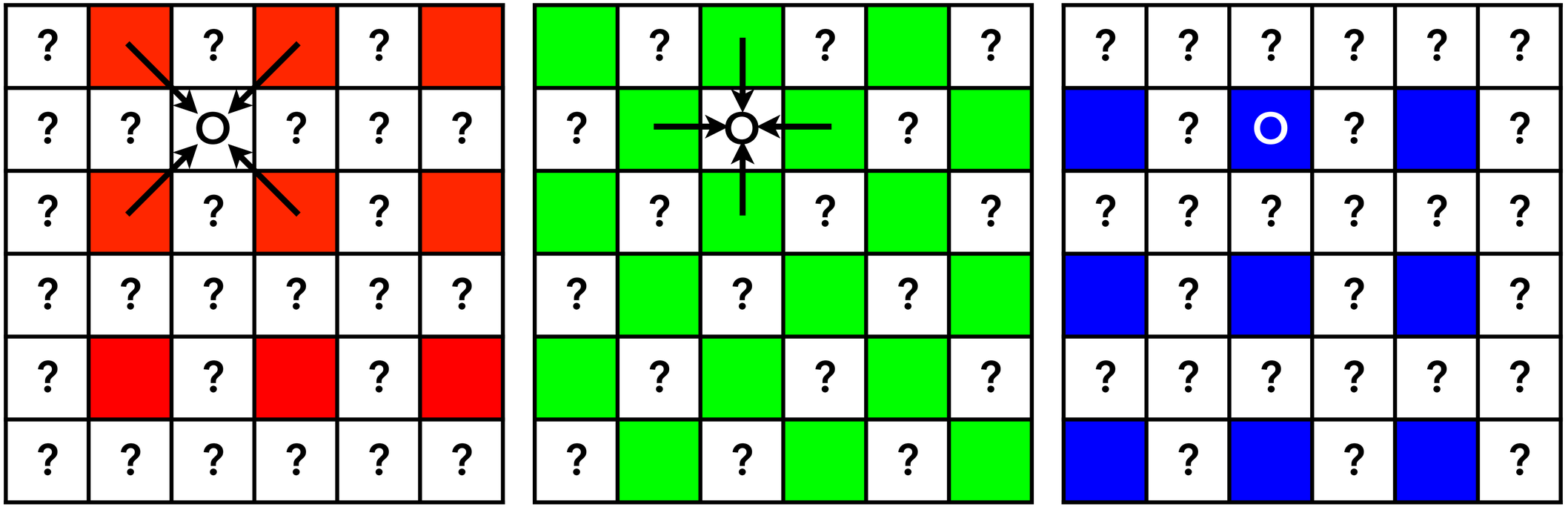
- **Problem 1:** resolution loss (megapixels so important for marketing!)
- **Problem 2**: produces subpixel shifts in color planes!



Centered half-resolution

Average pixels in groups that all have the same “center of gravity”

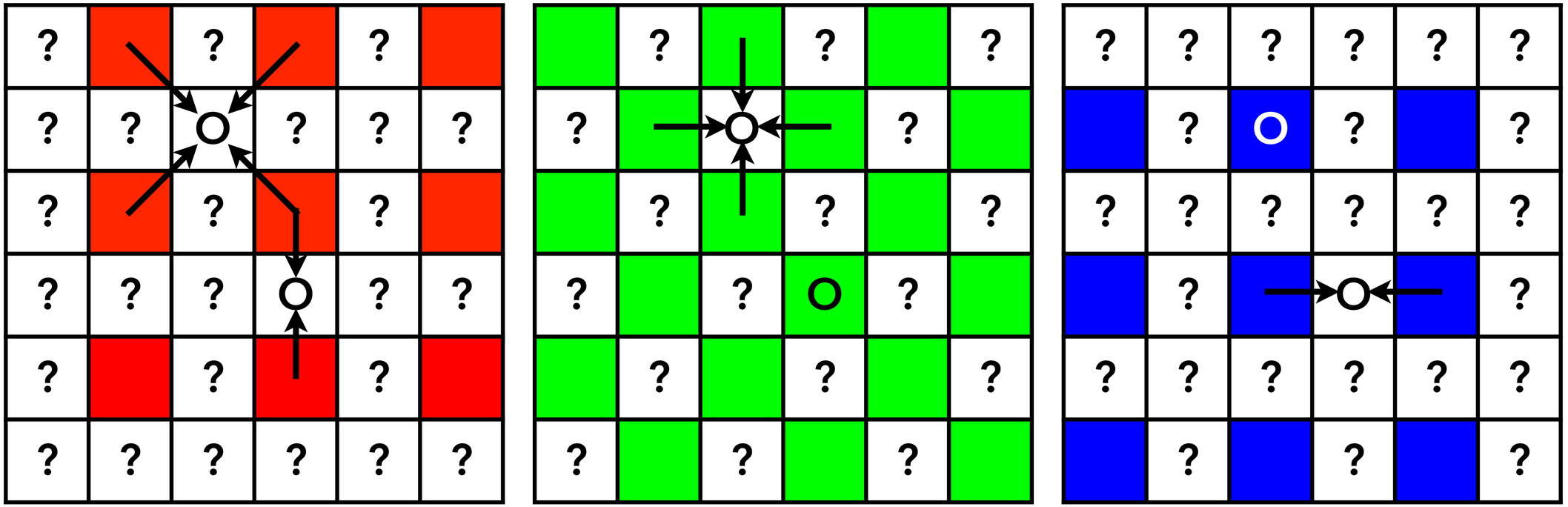
- avoids major color fringing



Linear interpolation

Average pixels in groups that all have the same “center of gravity”

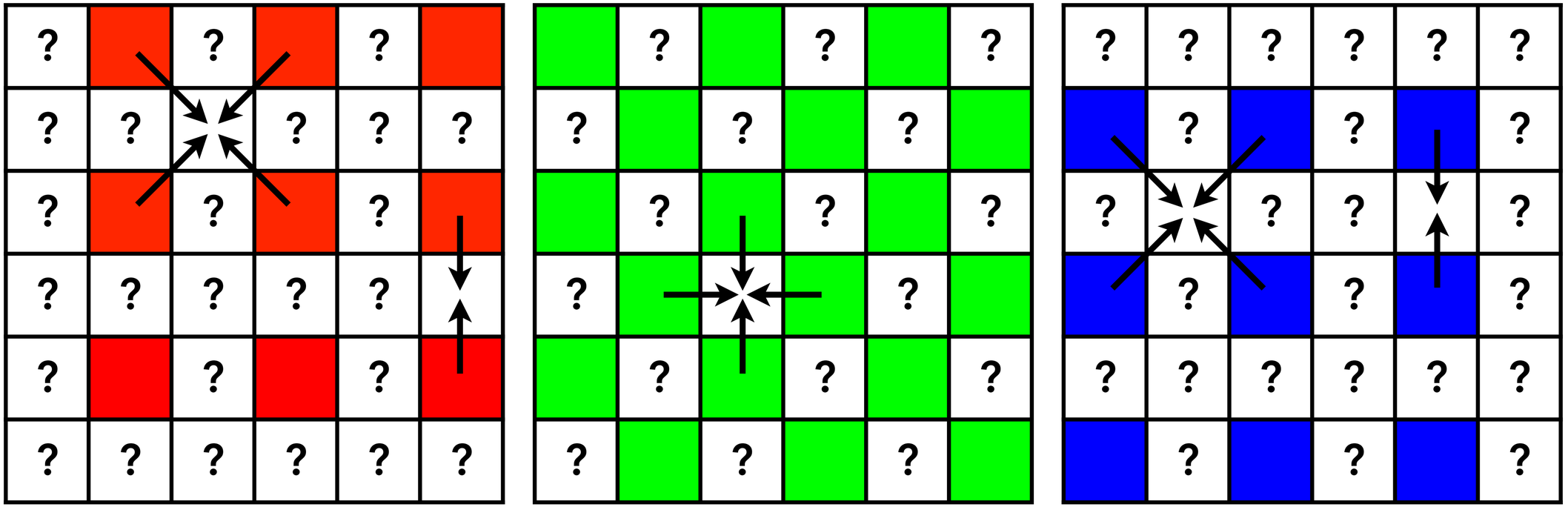
- avoids major color fringing



Linear interpolation

Average the 4 or 2 nearest neighbors (linear/tent kernel)

- e.g. `newgreen = 0.25 * (up+left+right+down)`



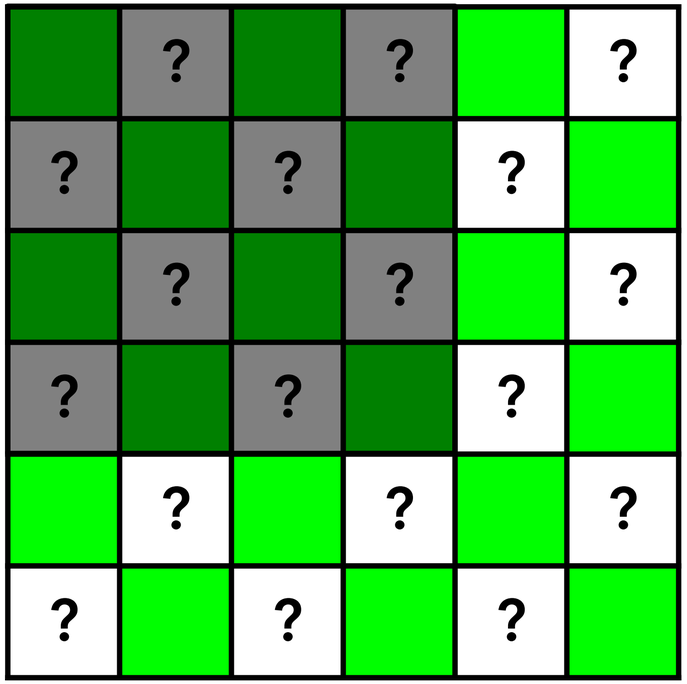
Results - not perfect

After a slide by Frédo Durand

The problem

Imagine a black-on-white corner

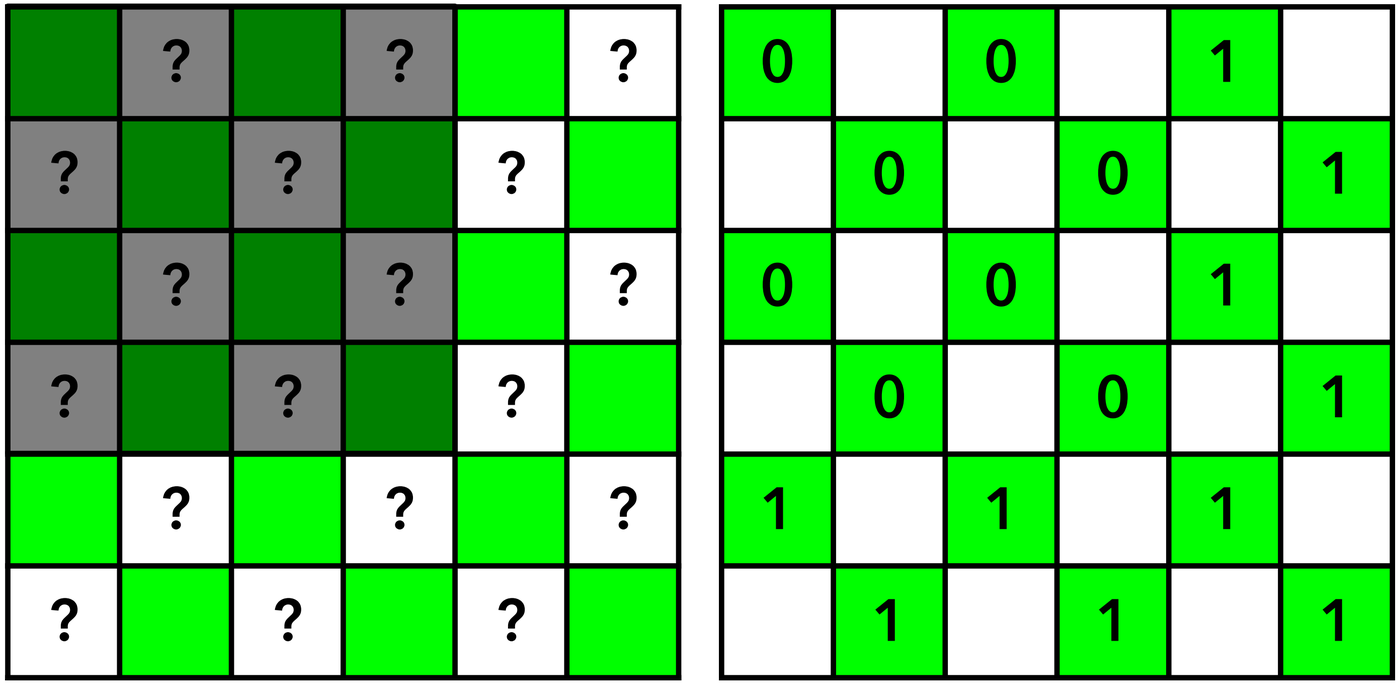
Let’s focus on the green channel for now



The problem

Imagine a black-on-white corner

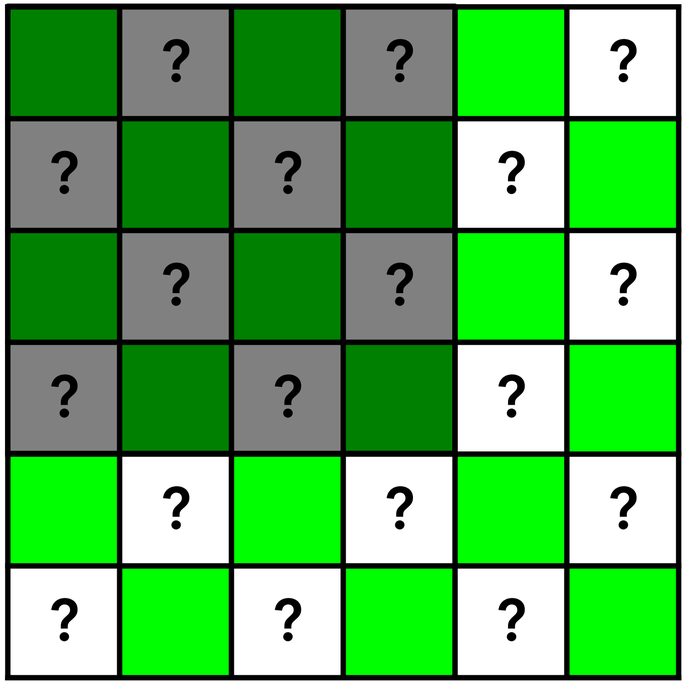
Let’s focus on the green channel for now

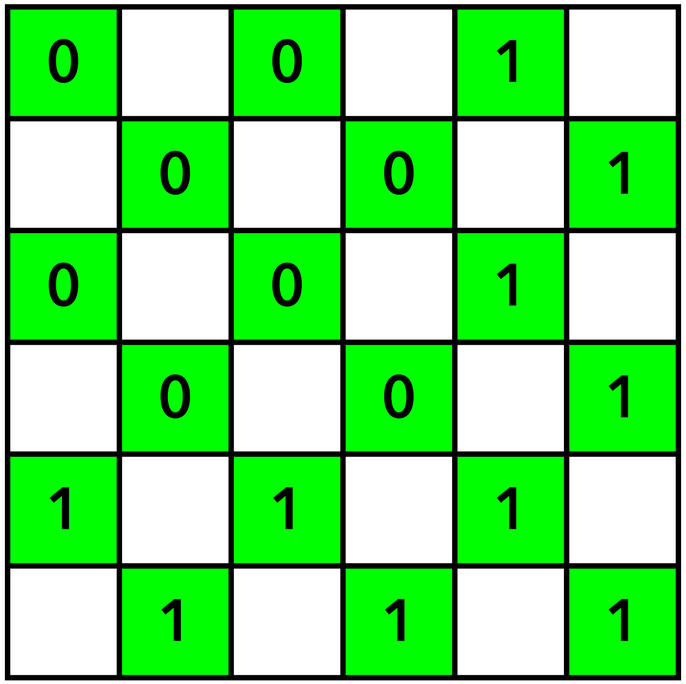


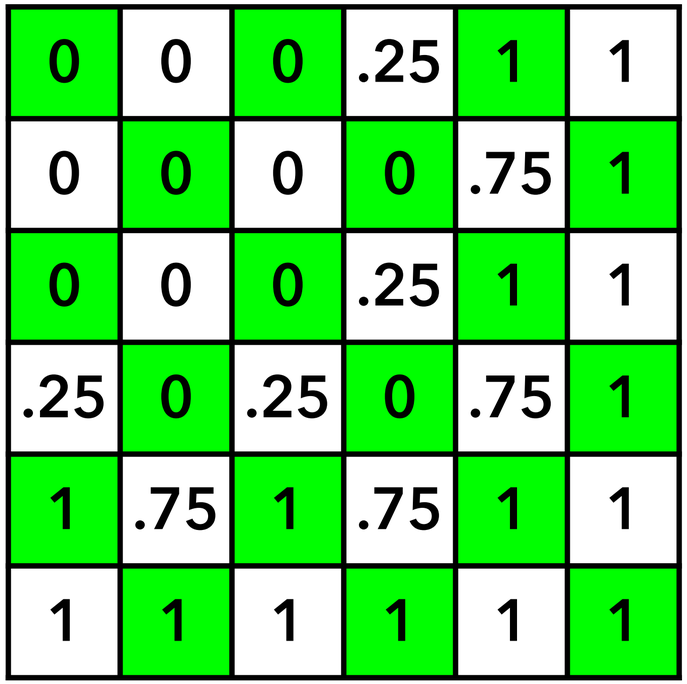
The problem

Imagine a black-on-white corner

Let’s focus on the green channel for now



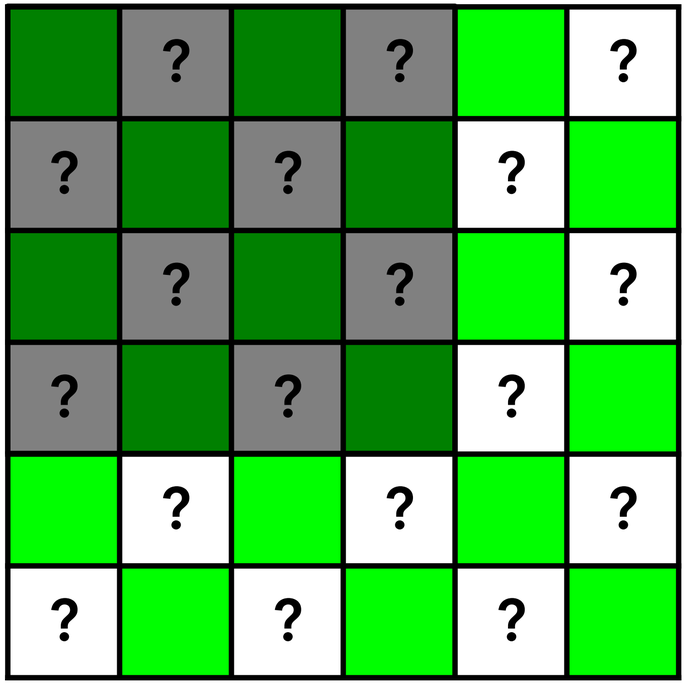


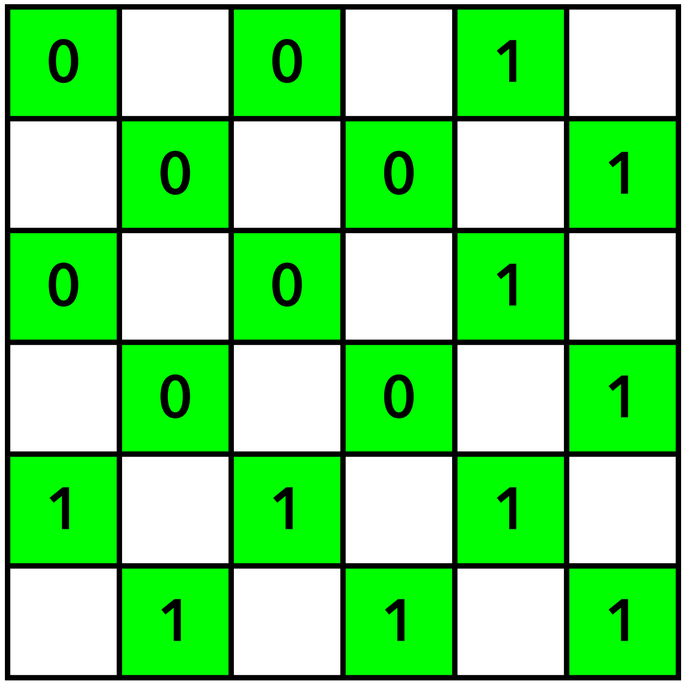


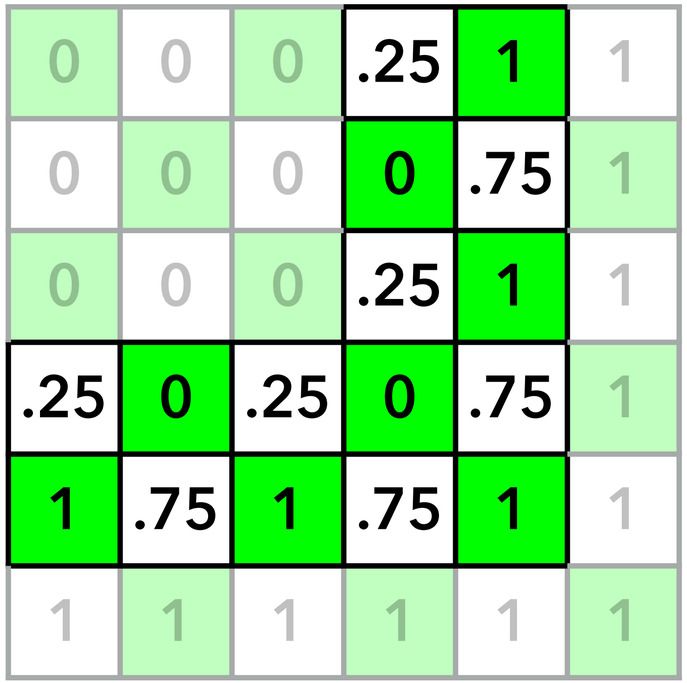
The problem

Imagine a black-on-white corner

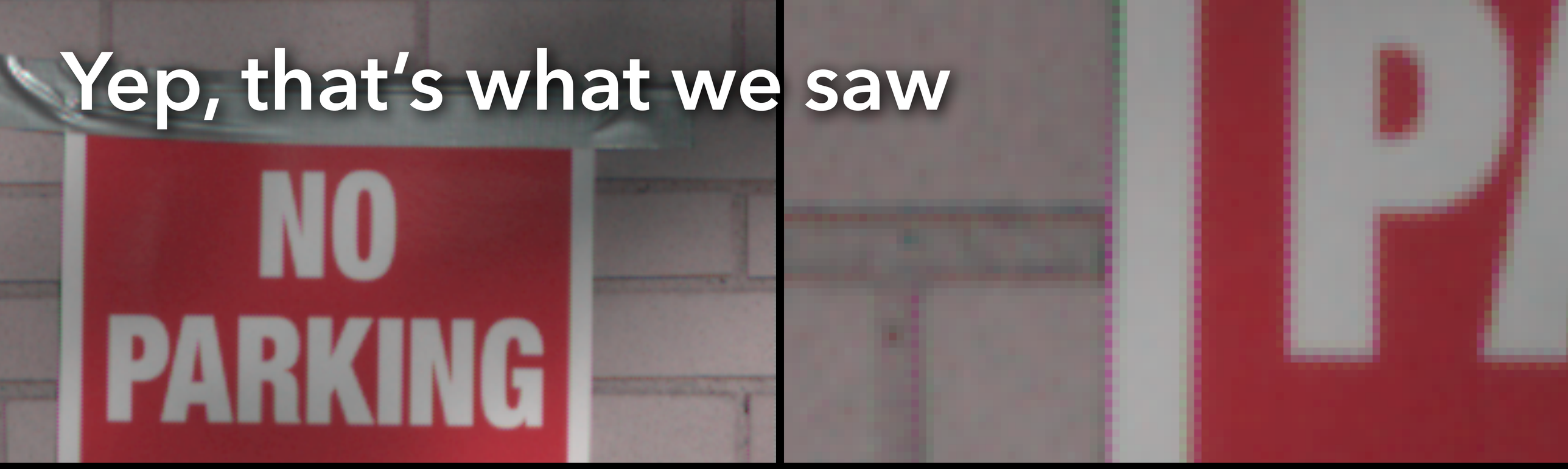
Let’s focus on the green channel for now







Yep, that's what we saw



After a slide by Frédo Durand

Green channel

After a slide by Frédo Durand

Edge-based Demosaicing

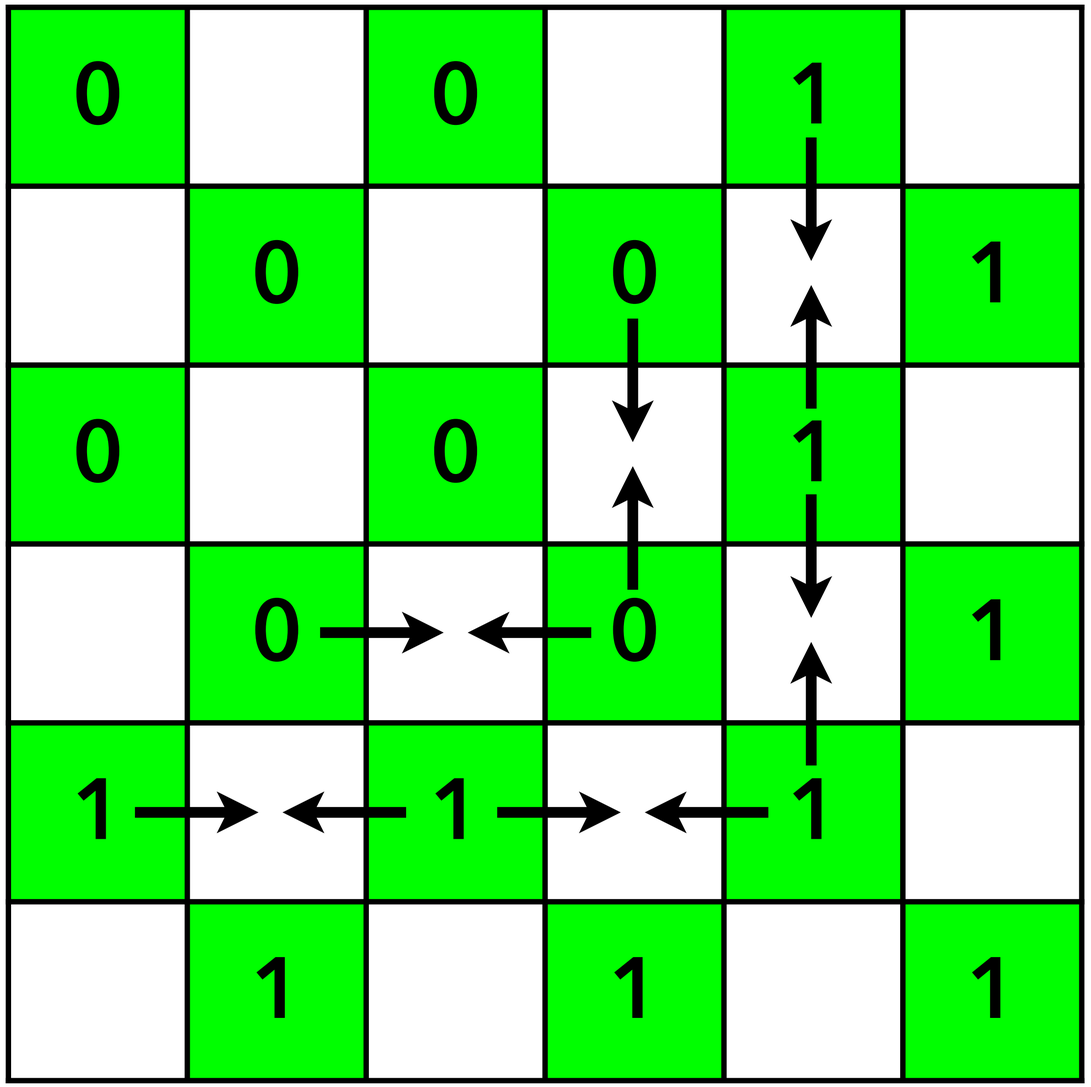
Idea

Take into account structure in image

- Here, 1D edges

Interpolate along preferred direction

- In our case, only use 2 neighbors

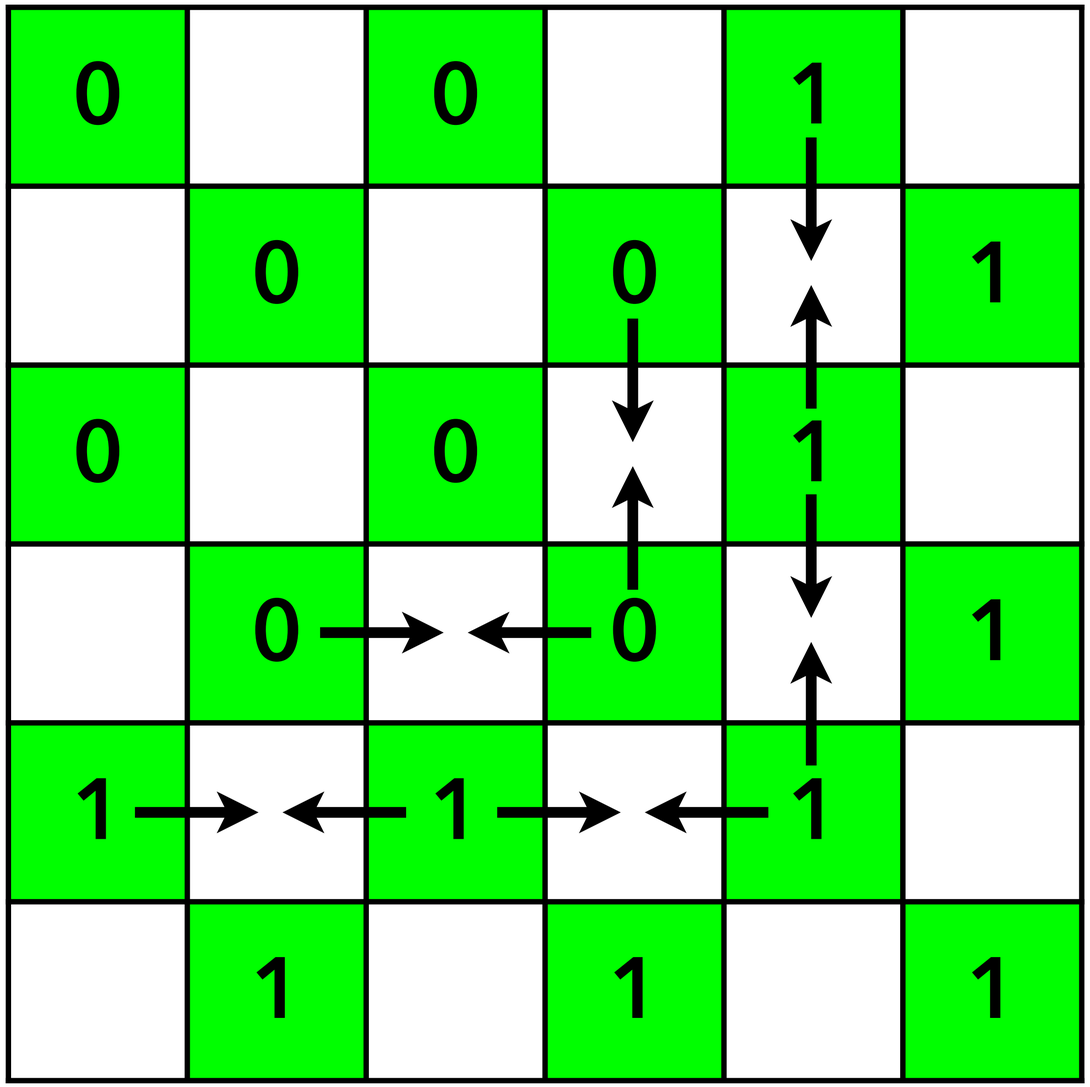


How do we decide?

Look at the similarity of recorded neighbors

- Compare |up-down| to |right-left|
- Be smart
- See Assignment 3

Called edge-based demosaicing



Green channel – naïve

After a slide by Frédo Durand

Green channel – edge-based

After a slide by Frédo Durand

Challenge with other channels

Problem

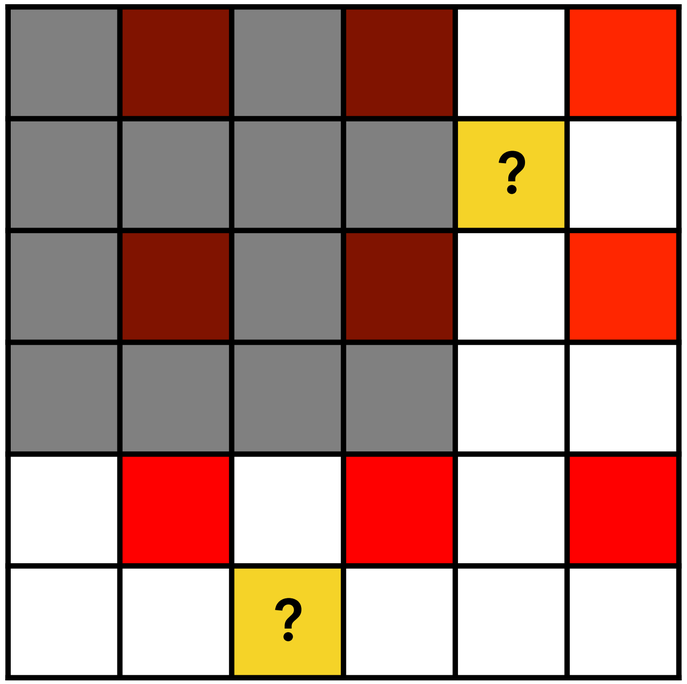
What do we do with red and blue?

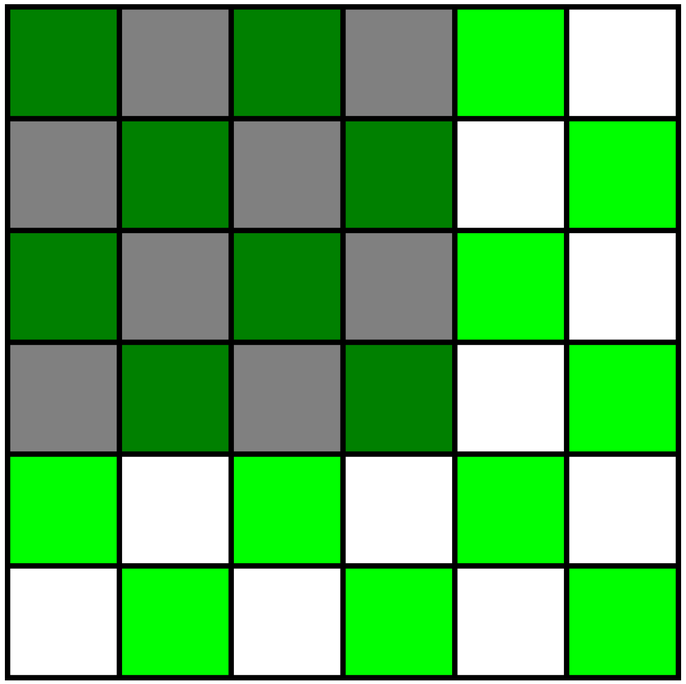
We could apply the edge-based principle

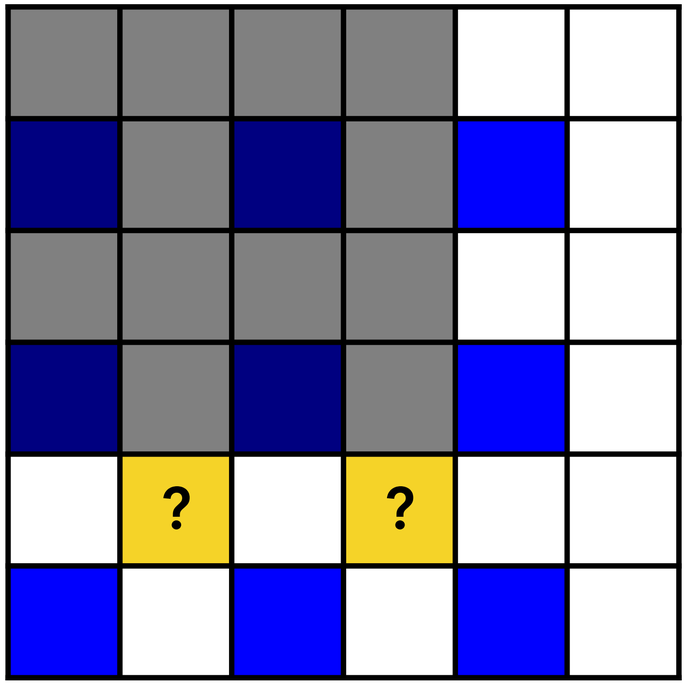
- but we're missing more information
- but color transitions might be shifted

Example (black-on-white corner)

Notion of edges unclear for pixels in empty rows/columns



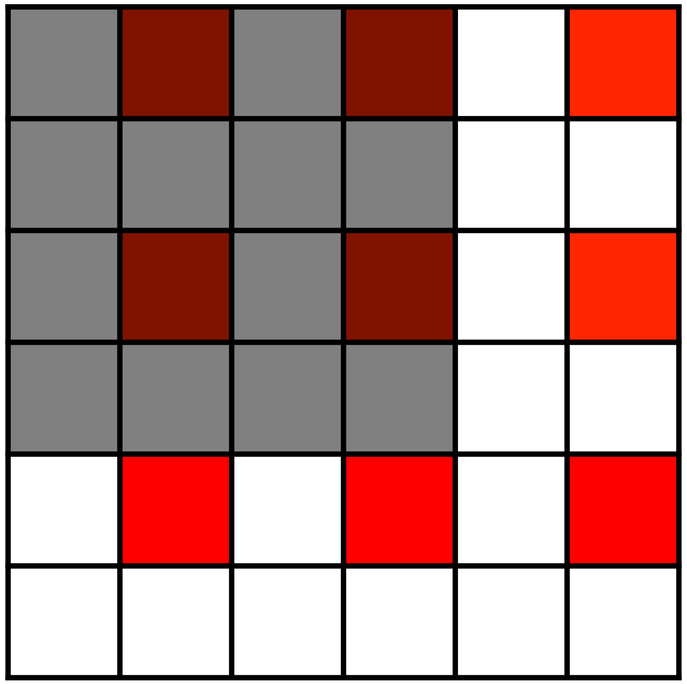


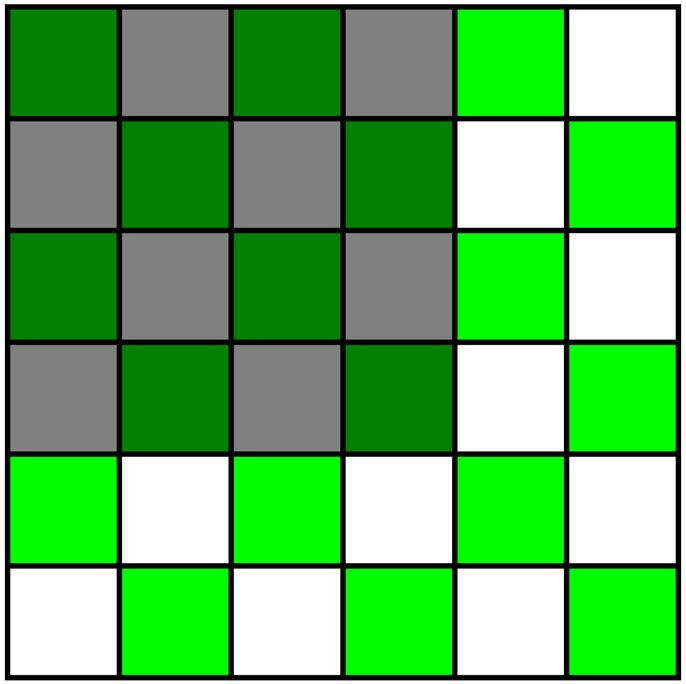


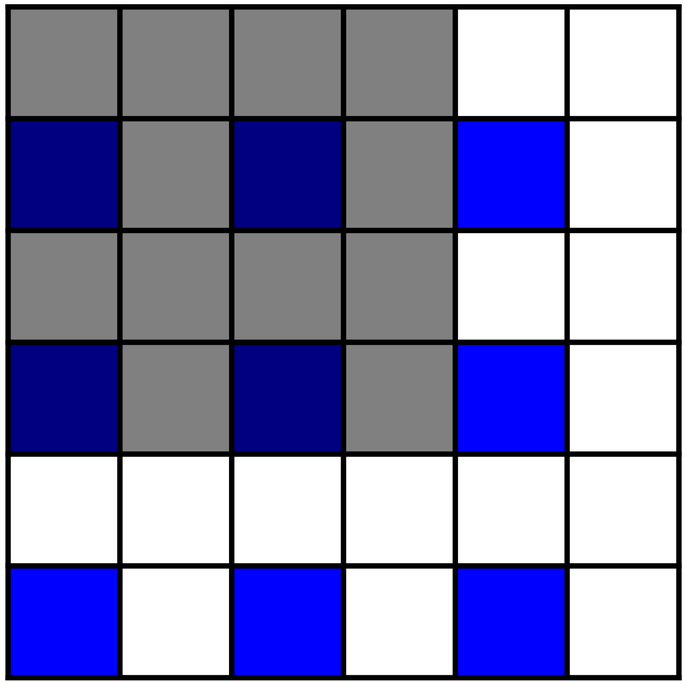
Example (black-on-white corner)

Even if we could do a decent job for each channel, the channels don't line up

- because they are not recorded at the same location



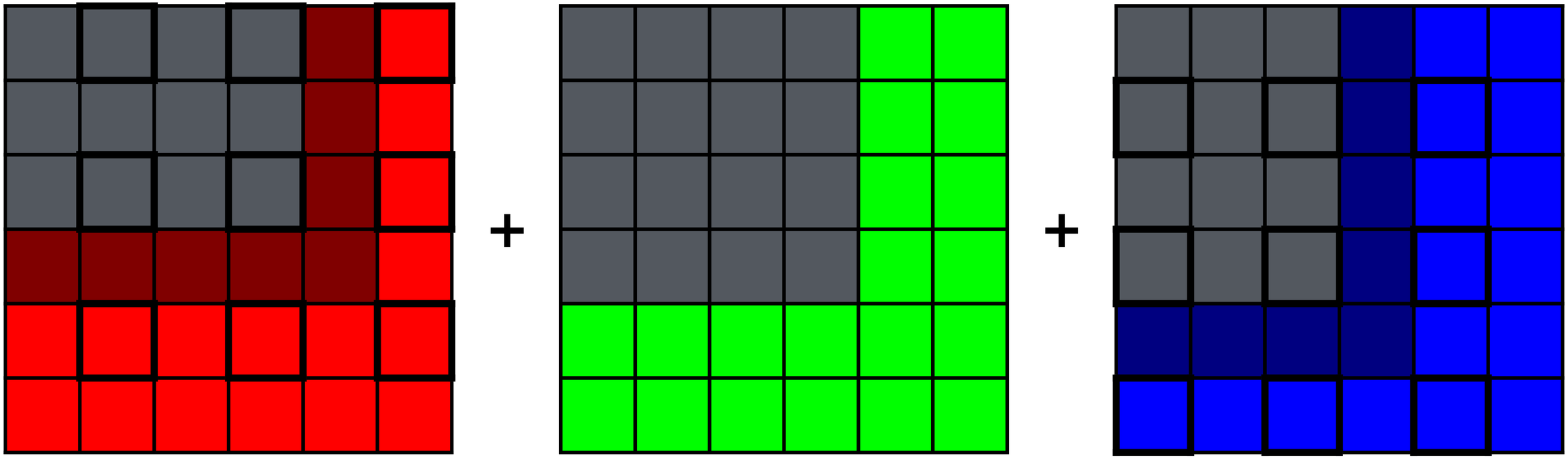




Example (black-on-white corner)

Even if we could do a decent job for each channel, the channels don't line up

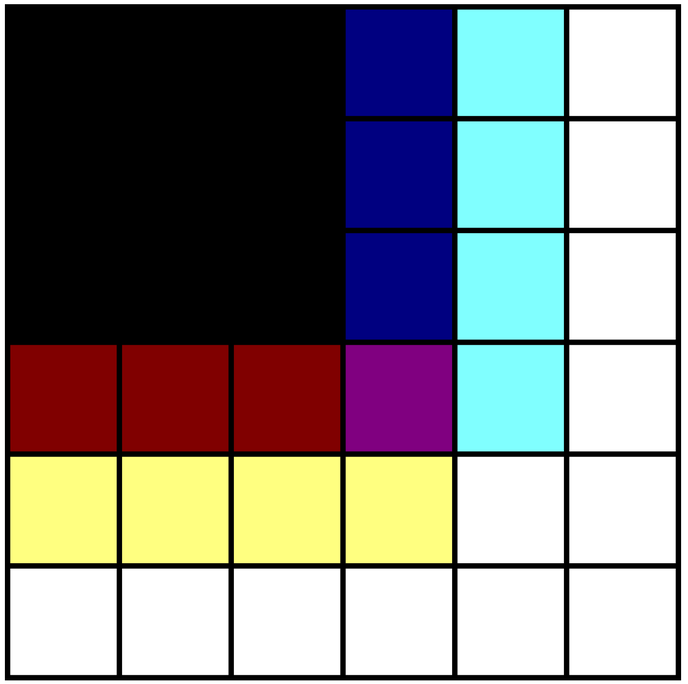
- because they are not recorded at the same location



Example (black-on-white corner)

Even if we could do a decent job for each channel, the channels don't line up

- because they are not recorded at the same location



Bad color fringes!

Recall color artifacts

After a slide by Frédo Durand

Green-based Demosaicing

Green-based demosaicing

Green is a better color channel

- Twice as many pixels
- Often better SNR
- We know how to do edge-based green interpolation

Do the best job you can and get high resolution from green

Then use green to guide red & blue interpolation

Interpolate difference to green

Interpolate green

- using e.g. edge-based

For recorded red pixels

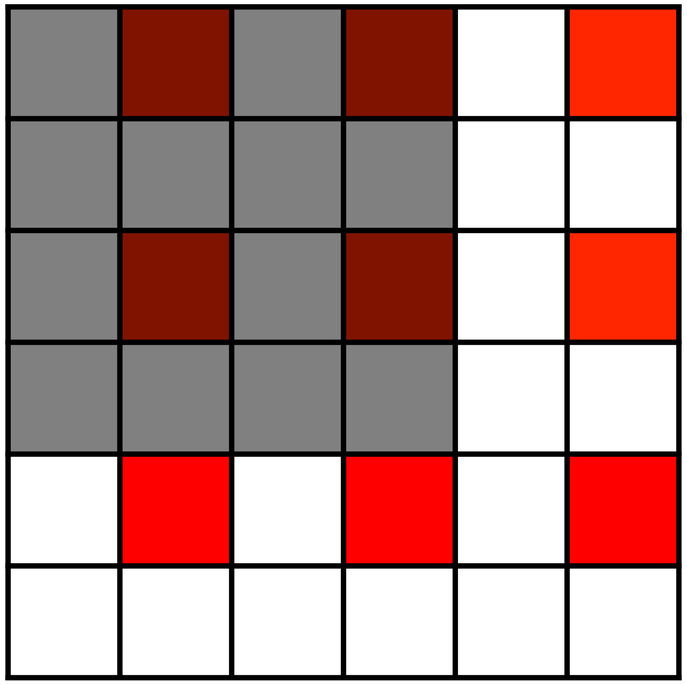
- compute R-G

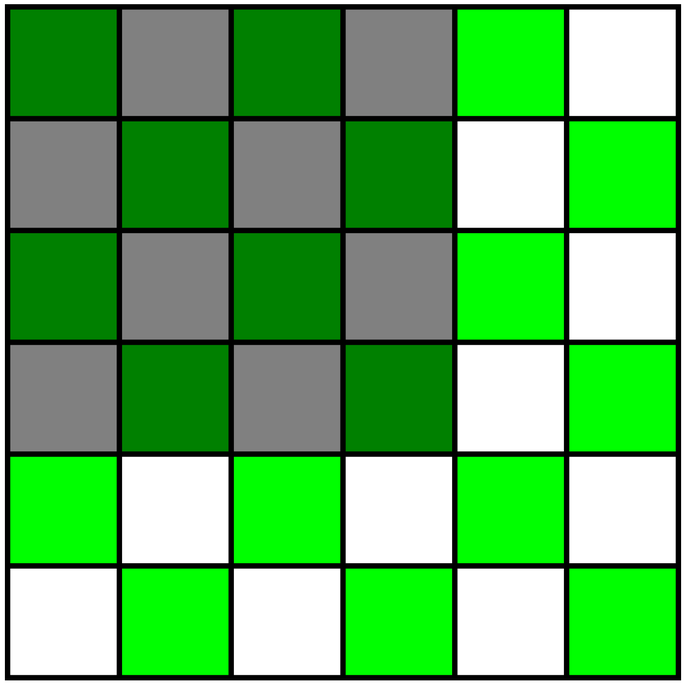
At empty pixels

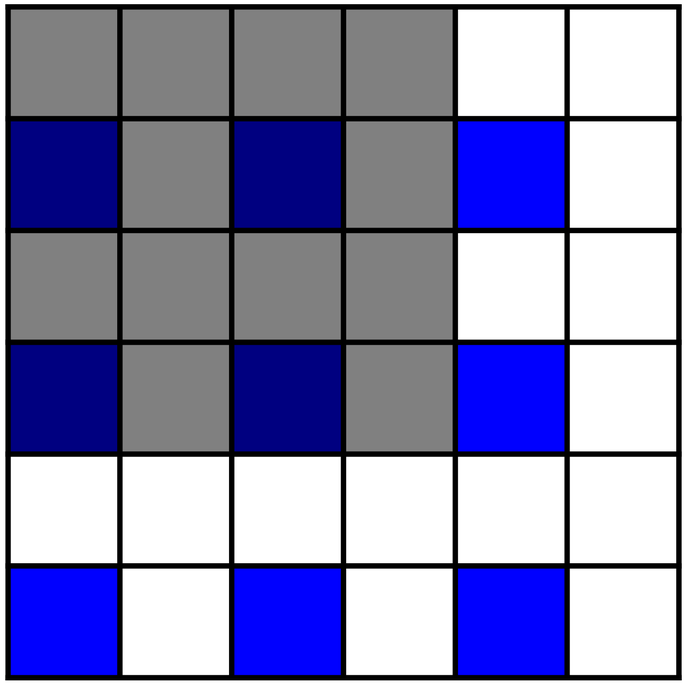
- Interpolate R-G naïvely
- Add G

Same for blue

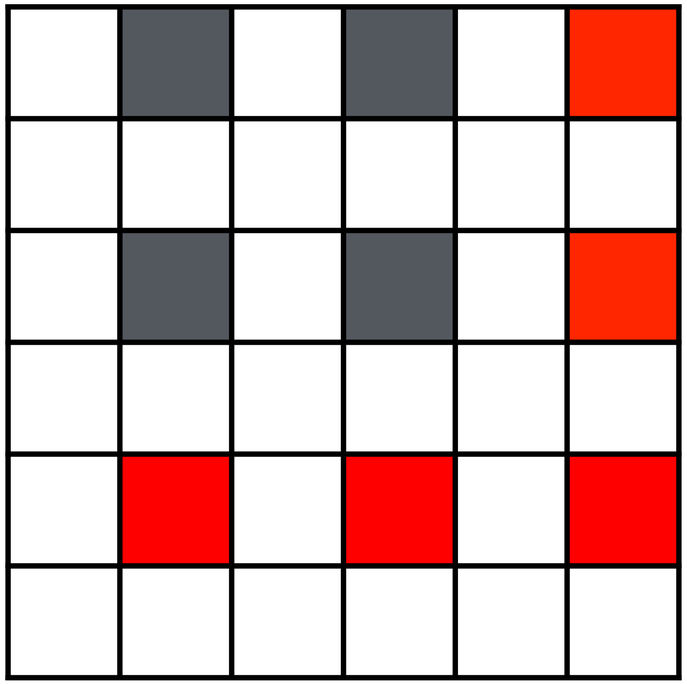
Black-on-white corner

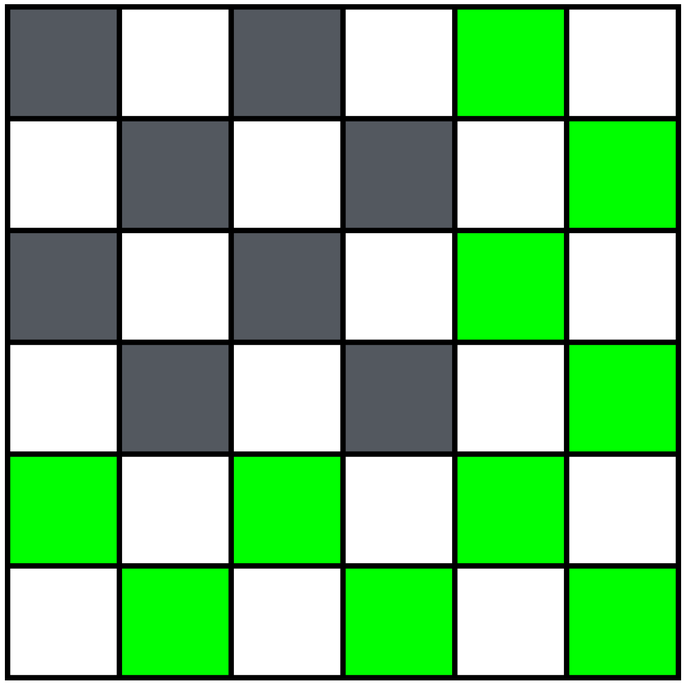


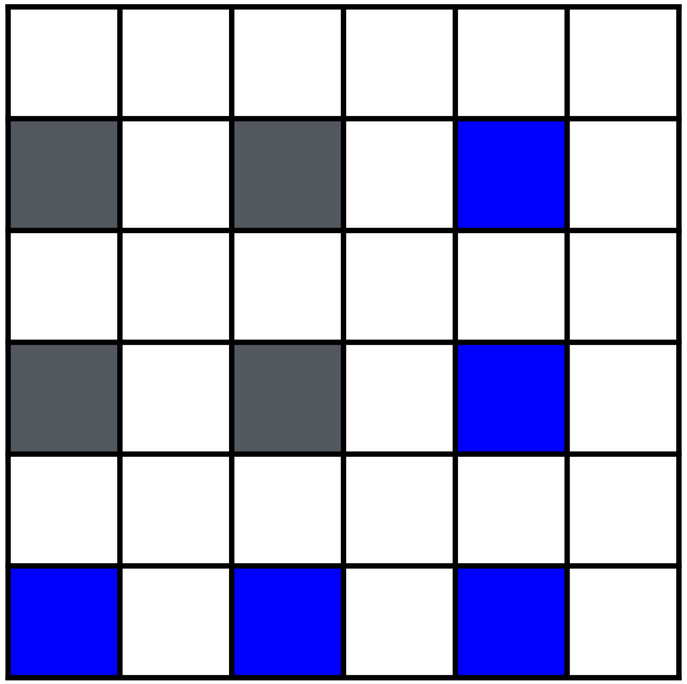




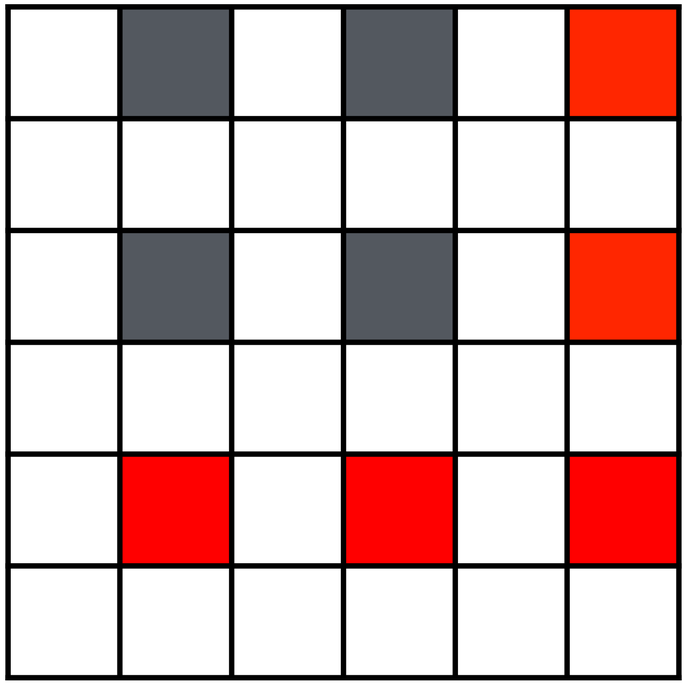
Measurements

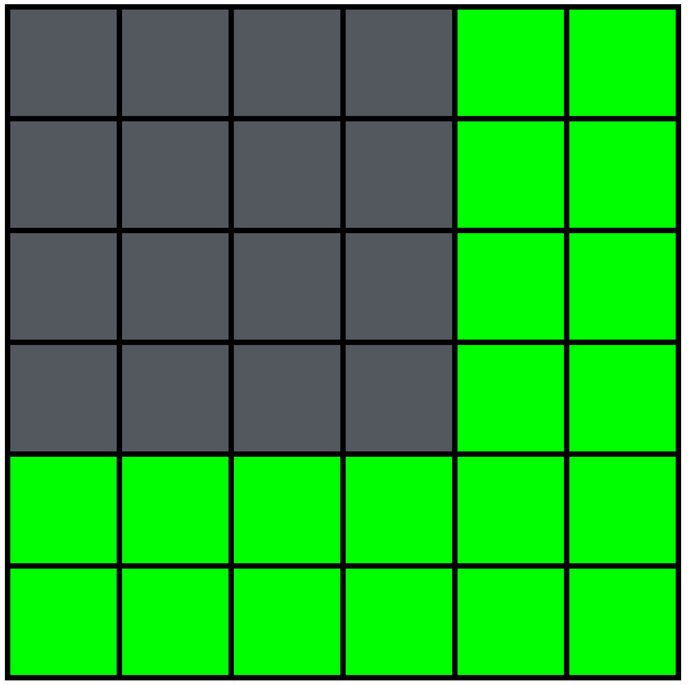


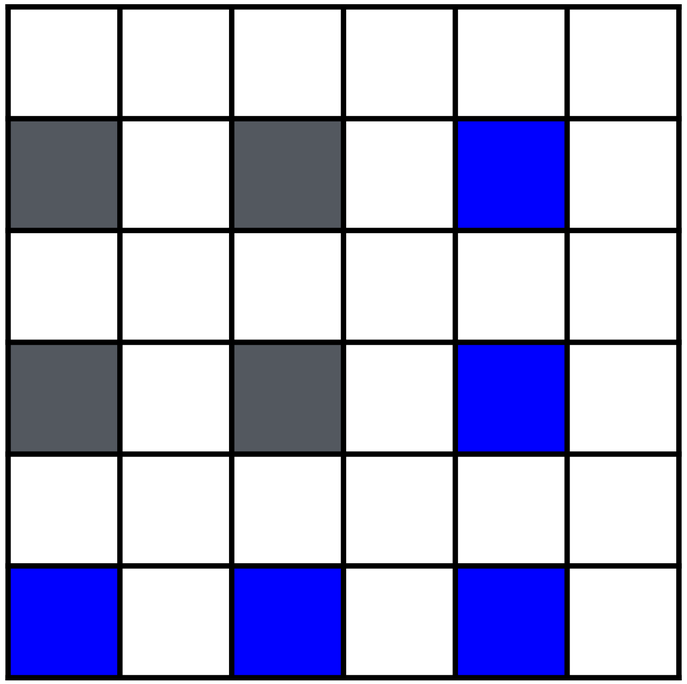




Edge-based green

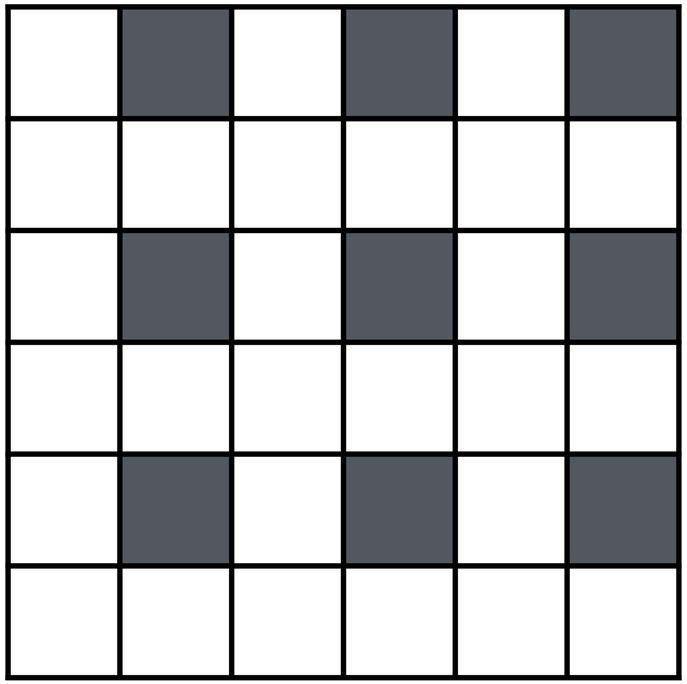


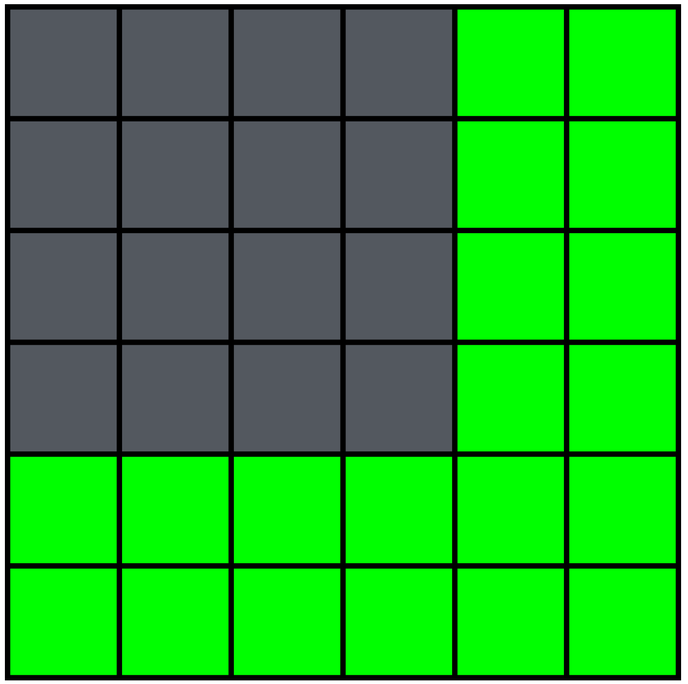


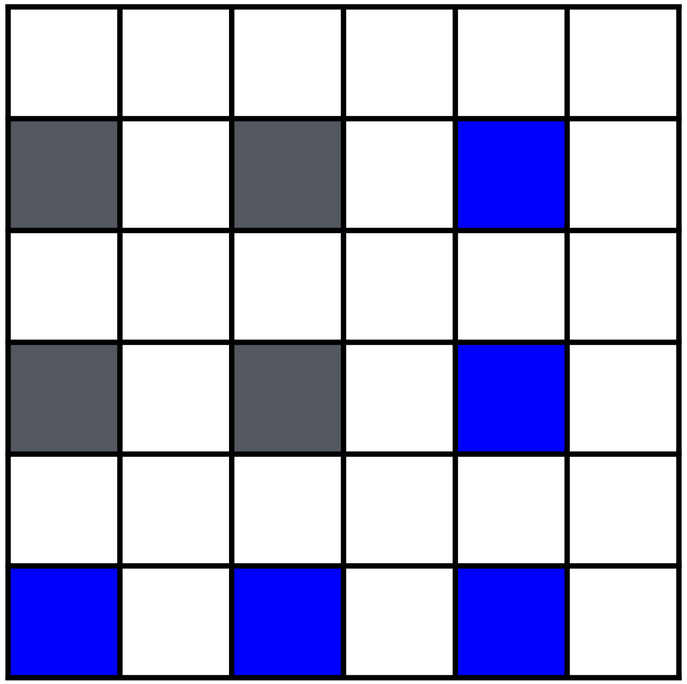


Red-Green difference

Zero everywhere!



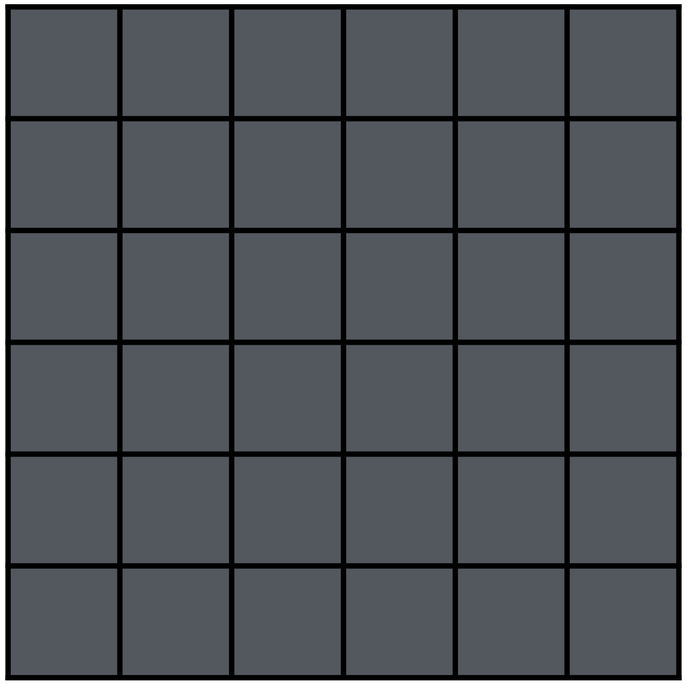


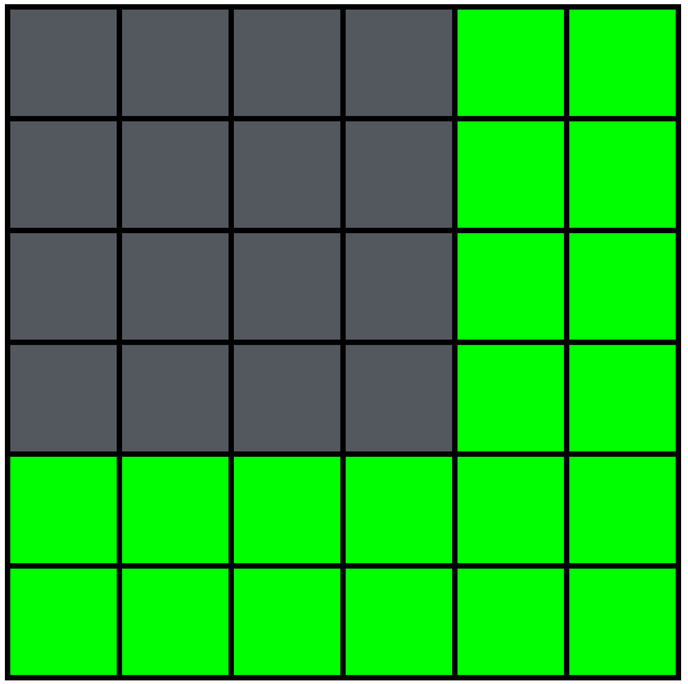


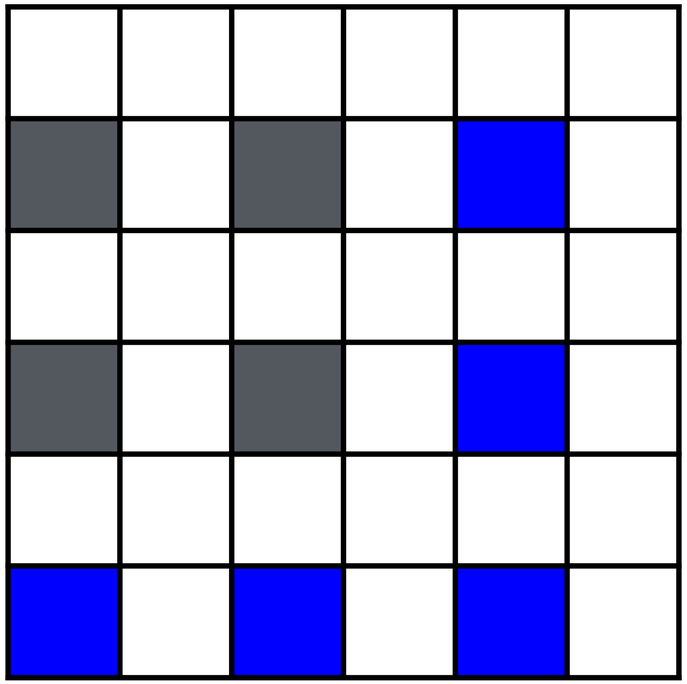
Red-Green difference

Zero everywhere!

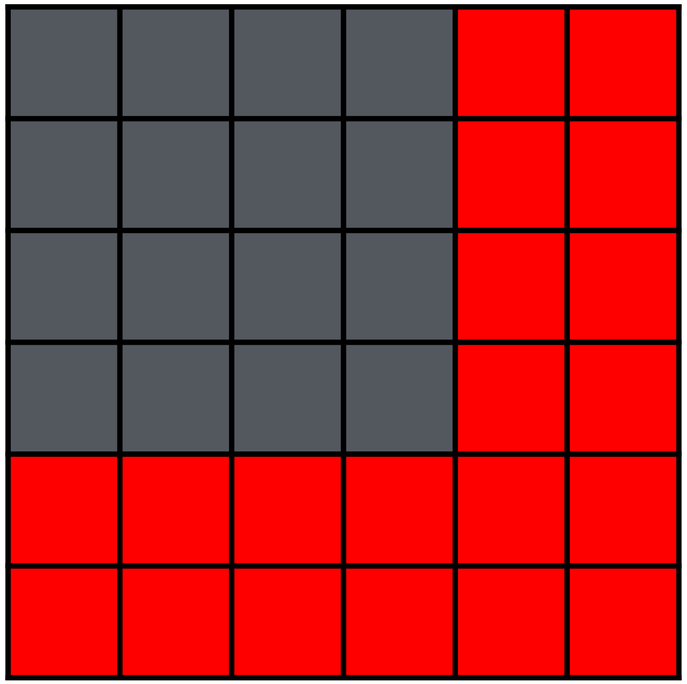
- Easy!

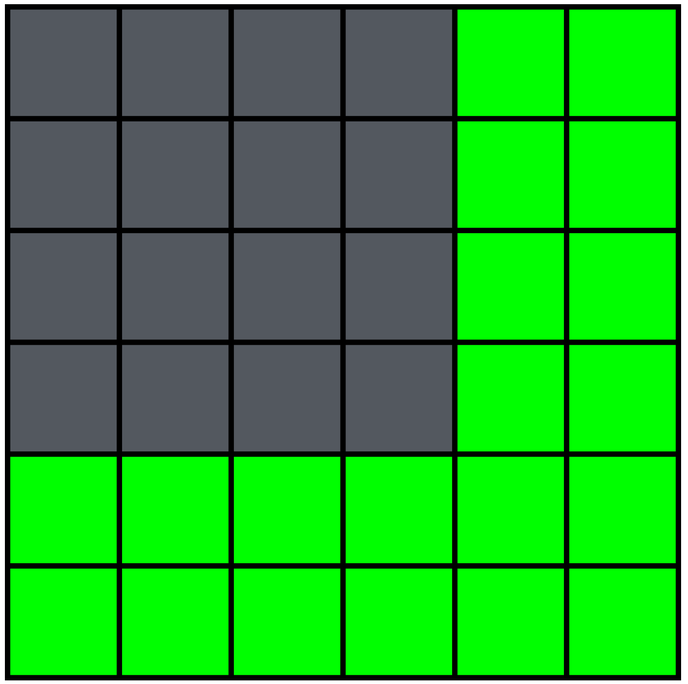


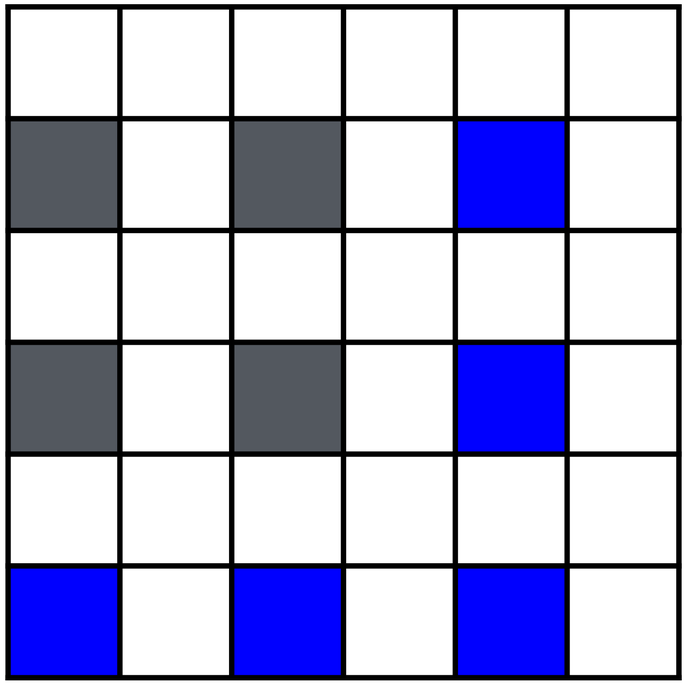




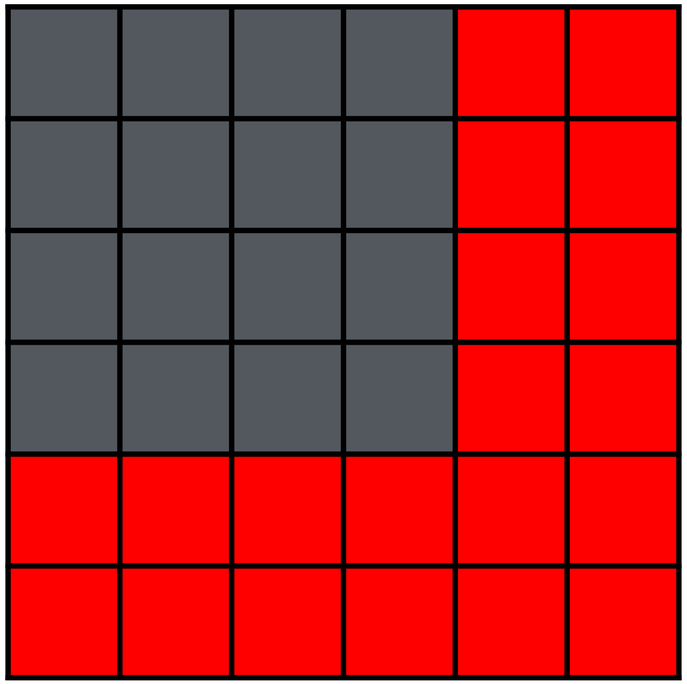
Add back green

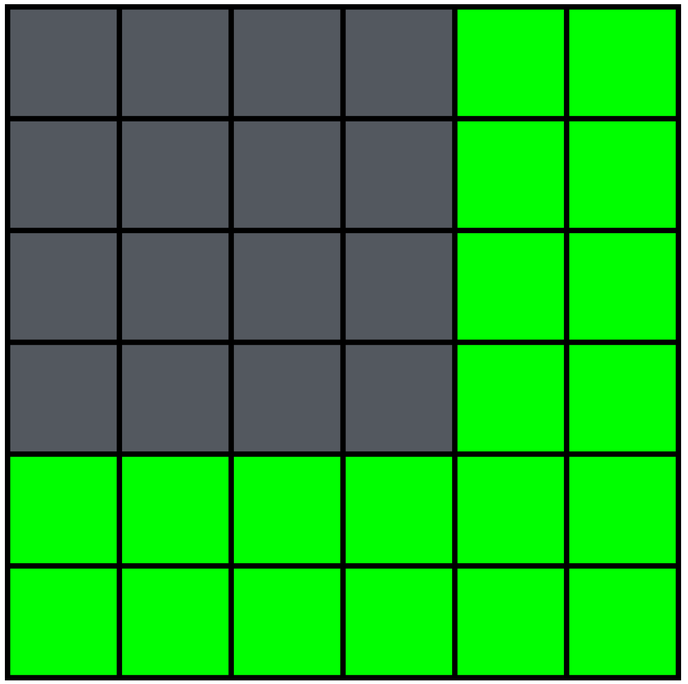


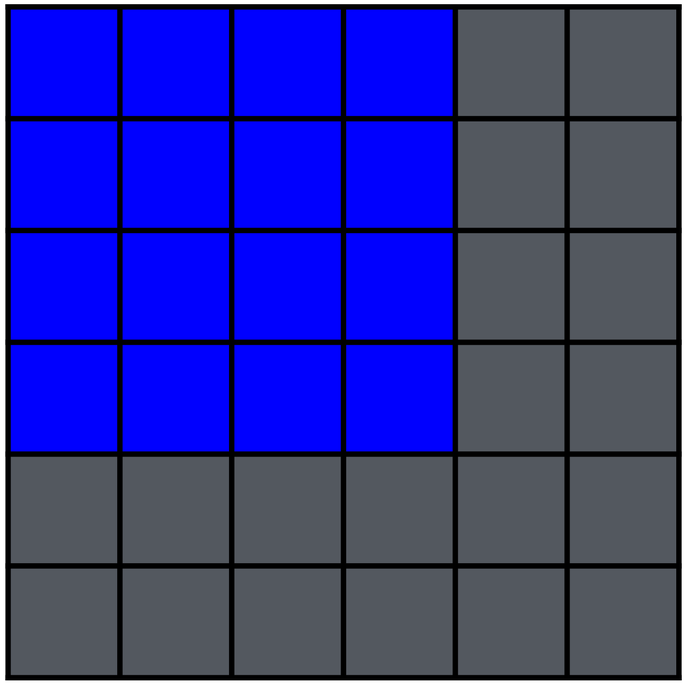




Repeat for blue



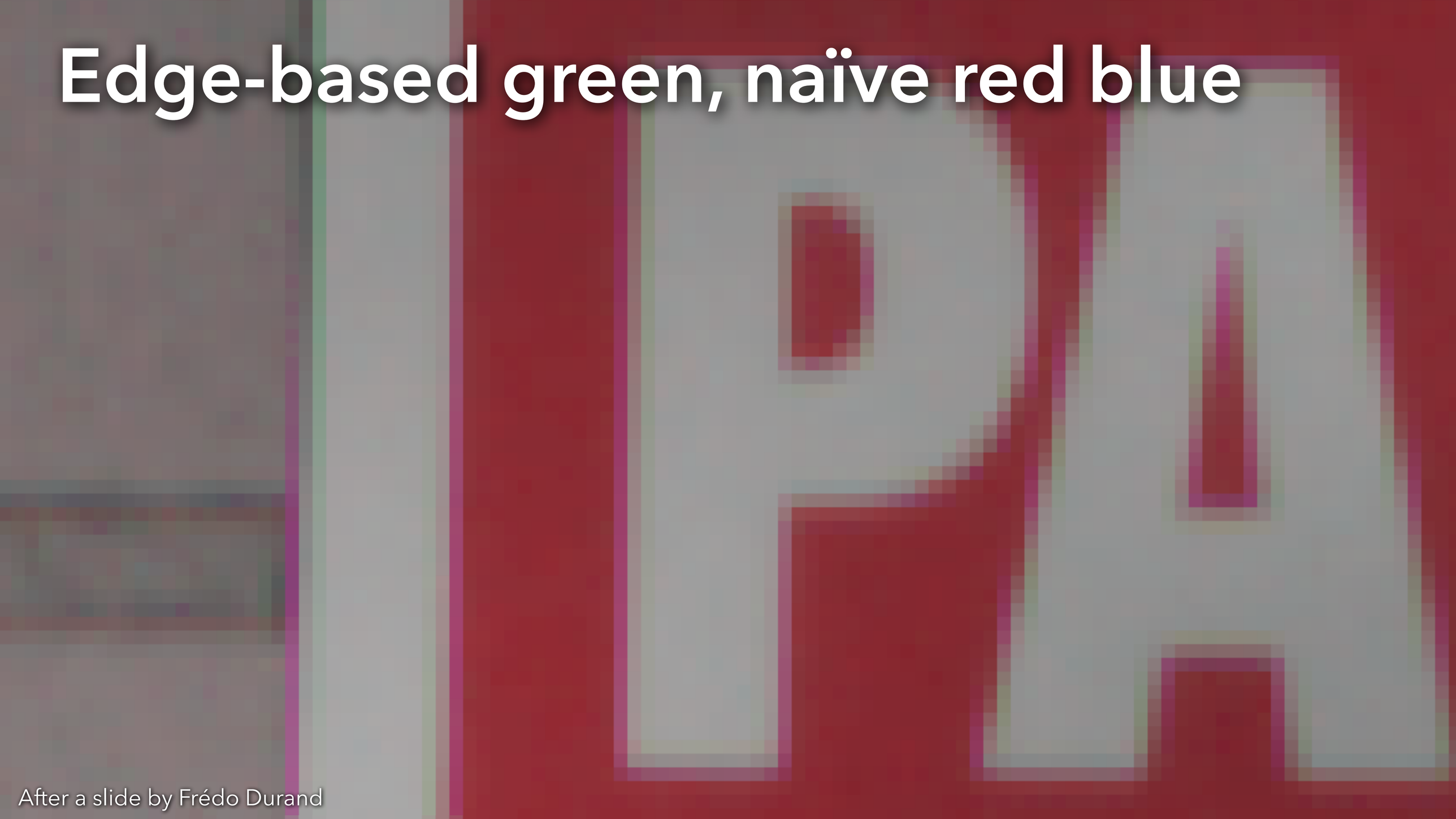




Fully naïve

After a slide by Frédo Durand

Edge-based green, naïve red blue

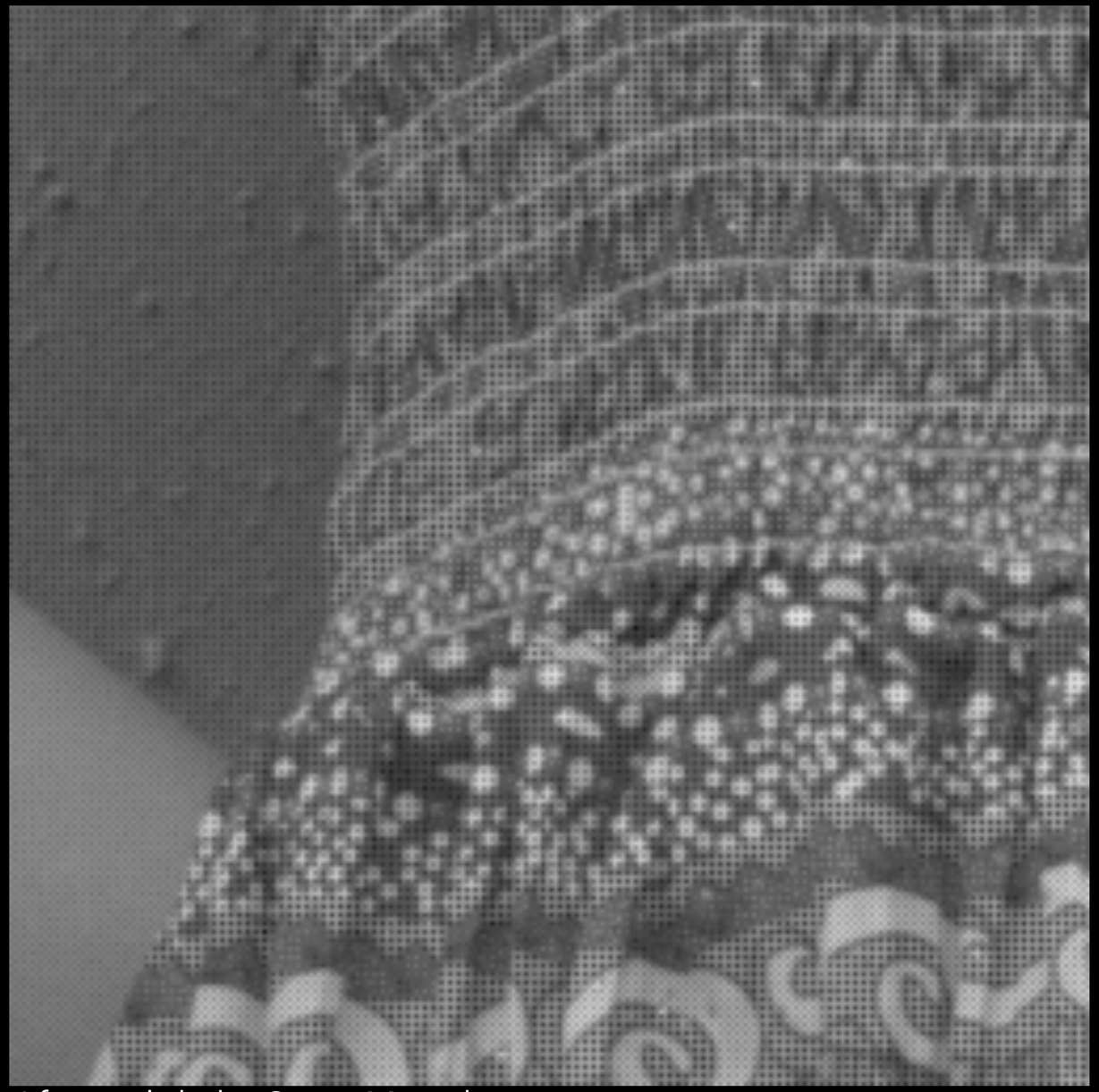


After a slide by Frédo Durand

Green-based blue and red

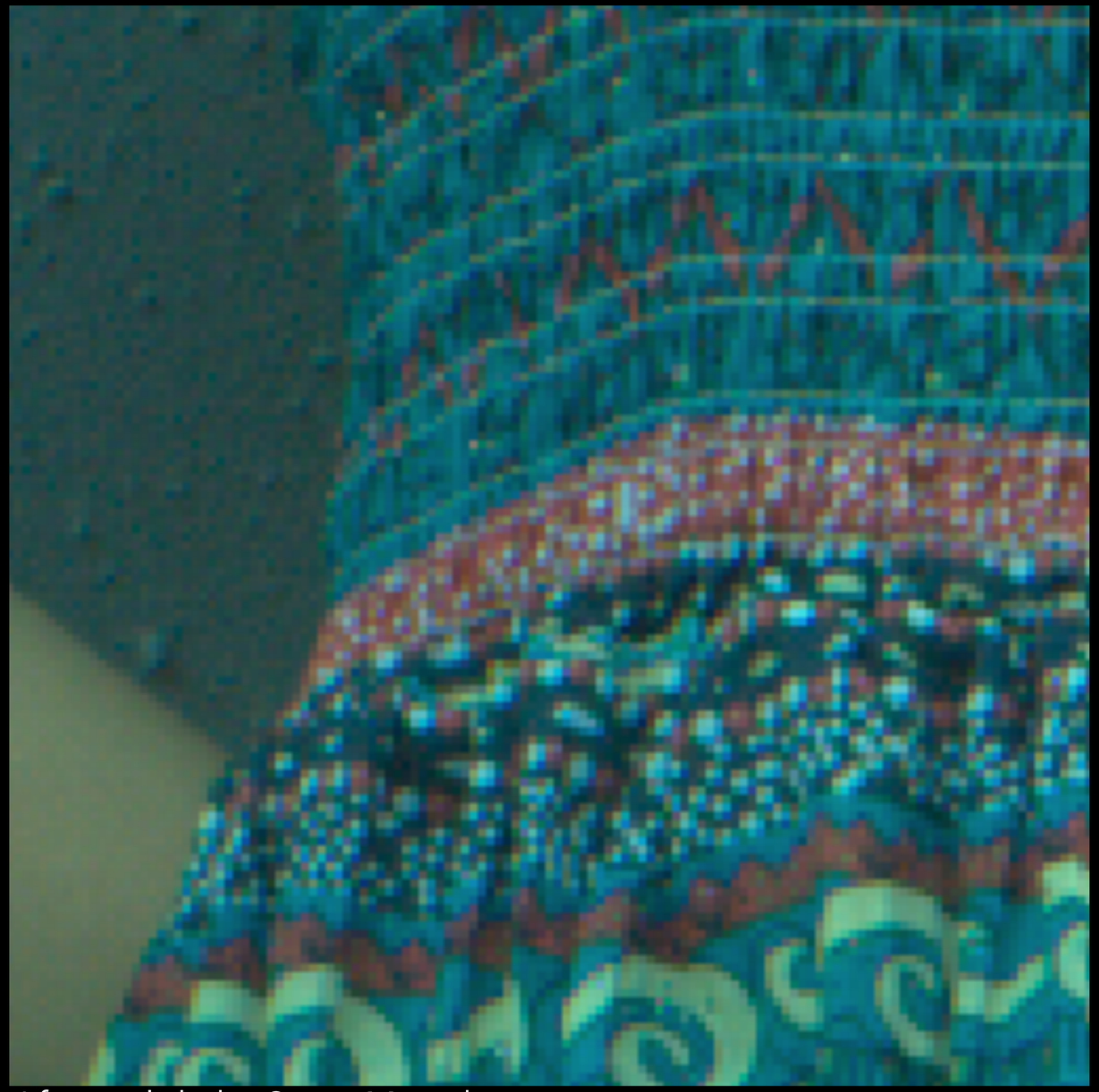
After a slide by Frédo Durand

RAW bayer data



After a slide by Steve Marschner

2x2 bayer block



After a slide by Steve Marschner

centered

After a slide by Steve Marschner

linear

After a slide by Steve Marschner

edge-based

After a slide by Steve Marschner