Raster Graphics

Raster images are ***pixel*** based.

Pixel = "picture element"

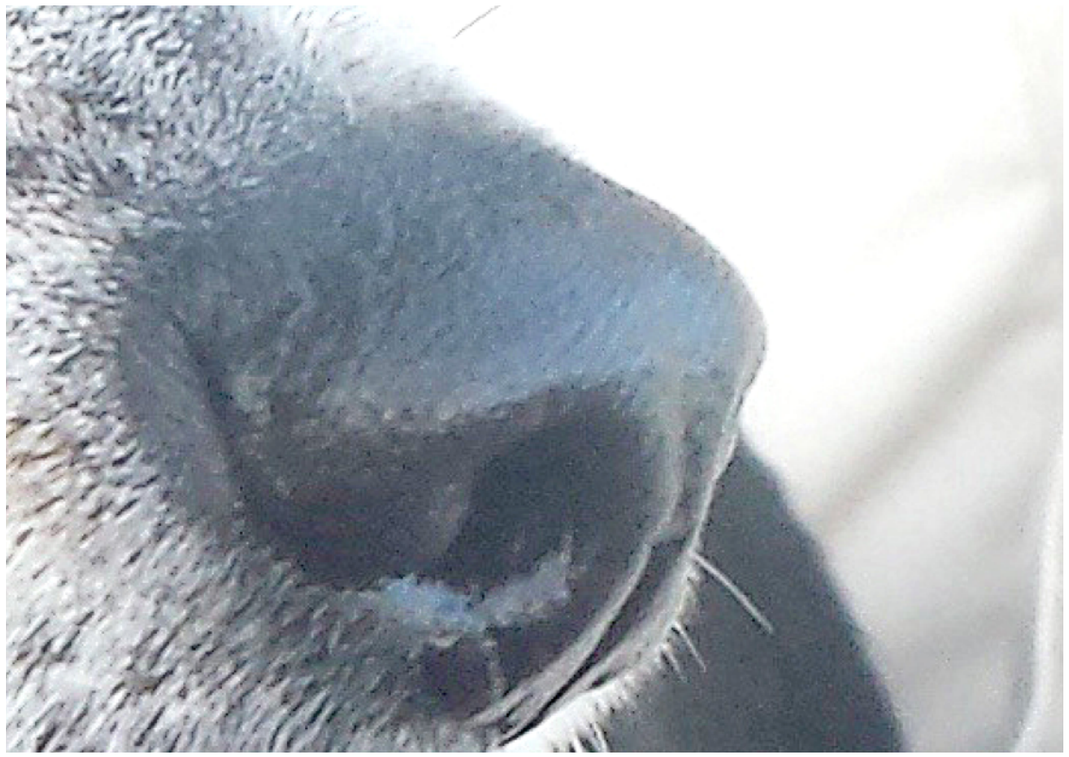
Pixels are the smallest unit of measure in a raster file…

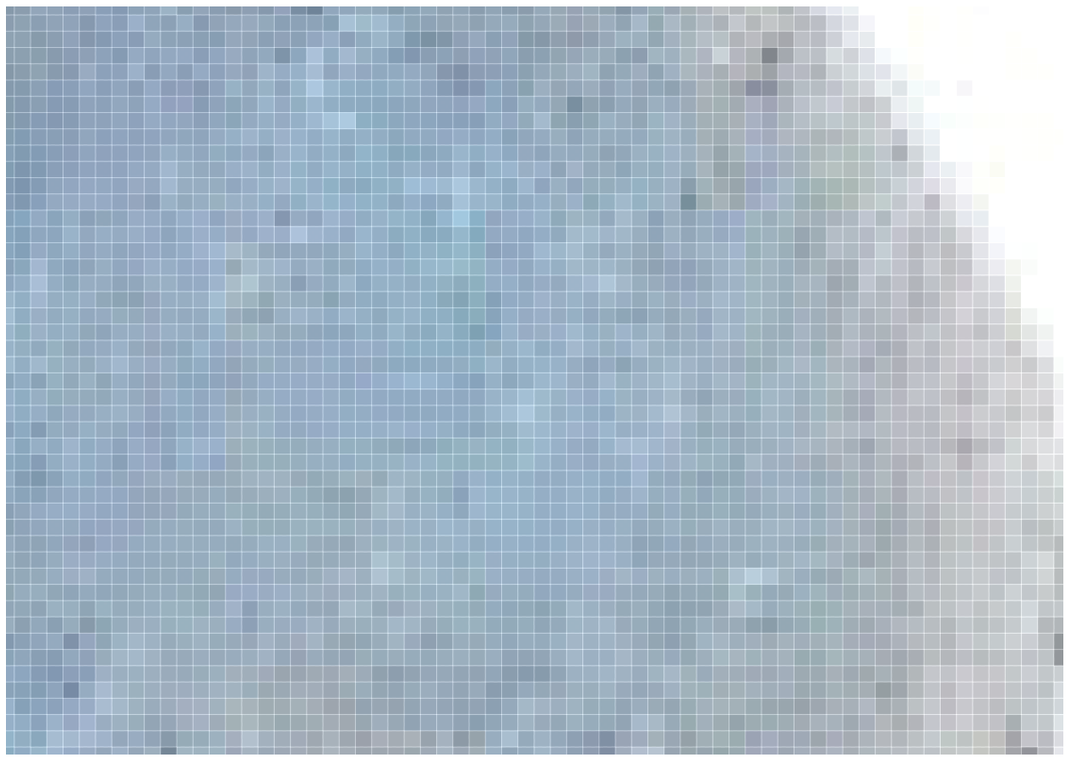
... and they are the basis of *resolution* in a raster file.

Thus,
pixel density = *resolution*

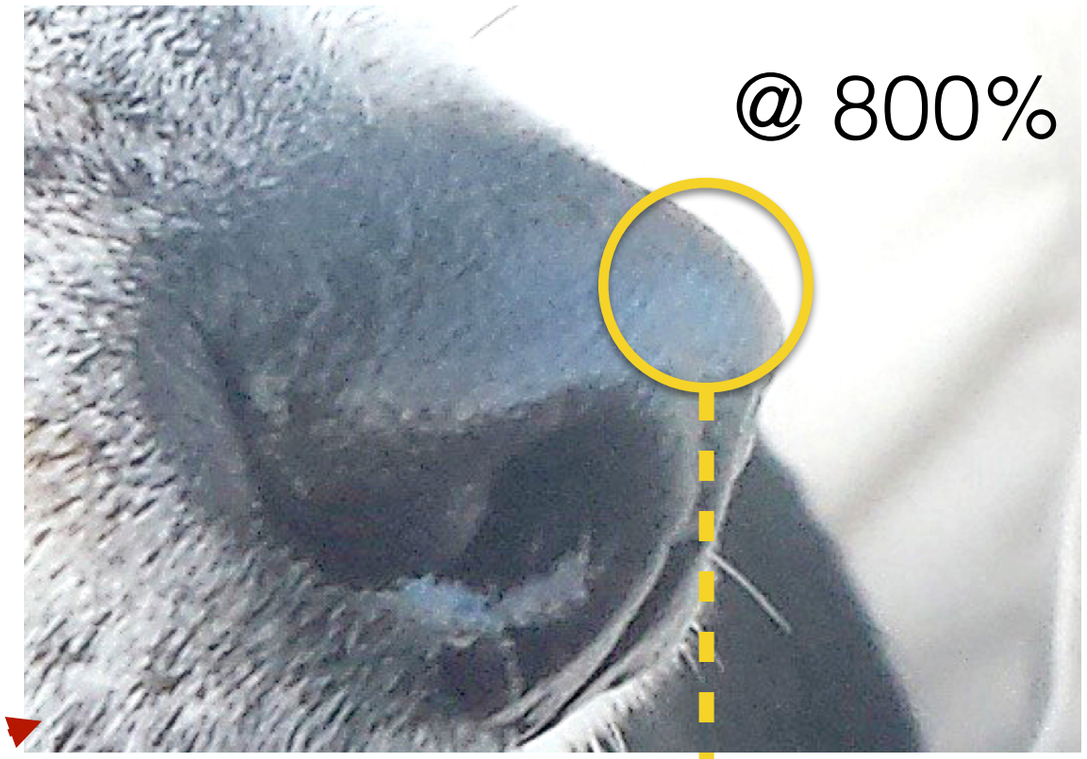
***Resolution* is measured in pixels per inch (ppi)**

Same picture…





…scaled on a laptop screen with 1440 x 900 resolution



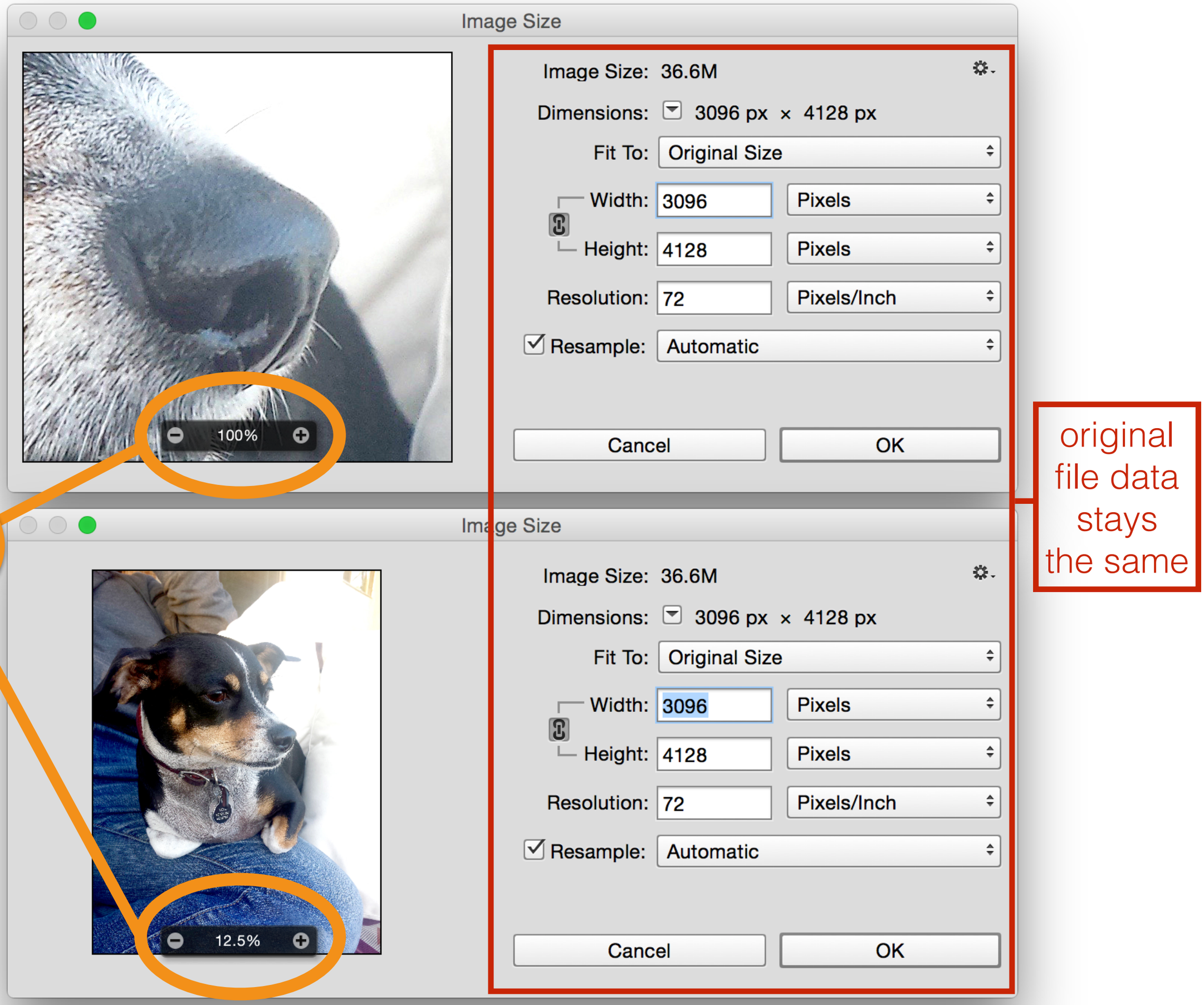
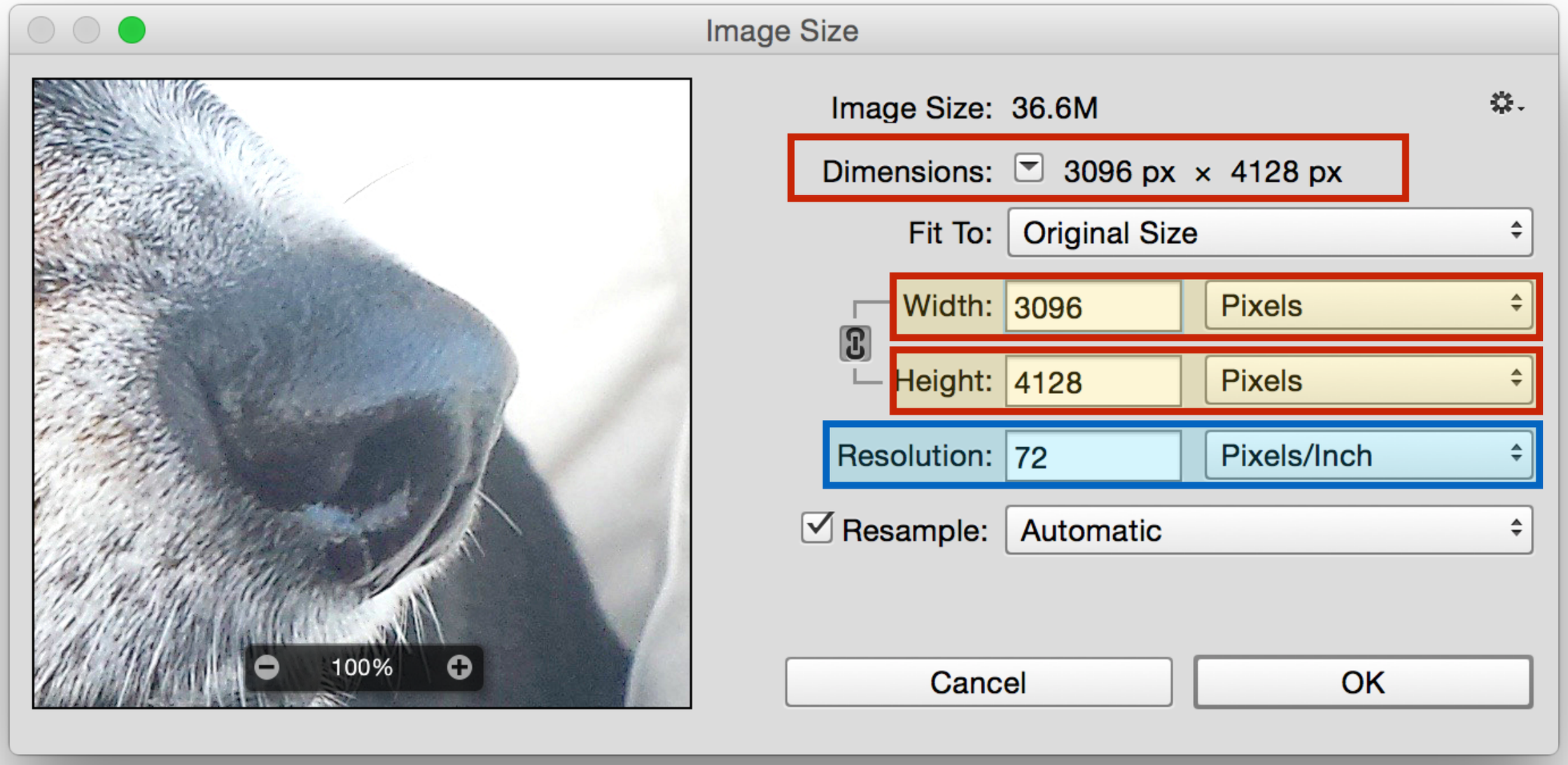


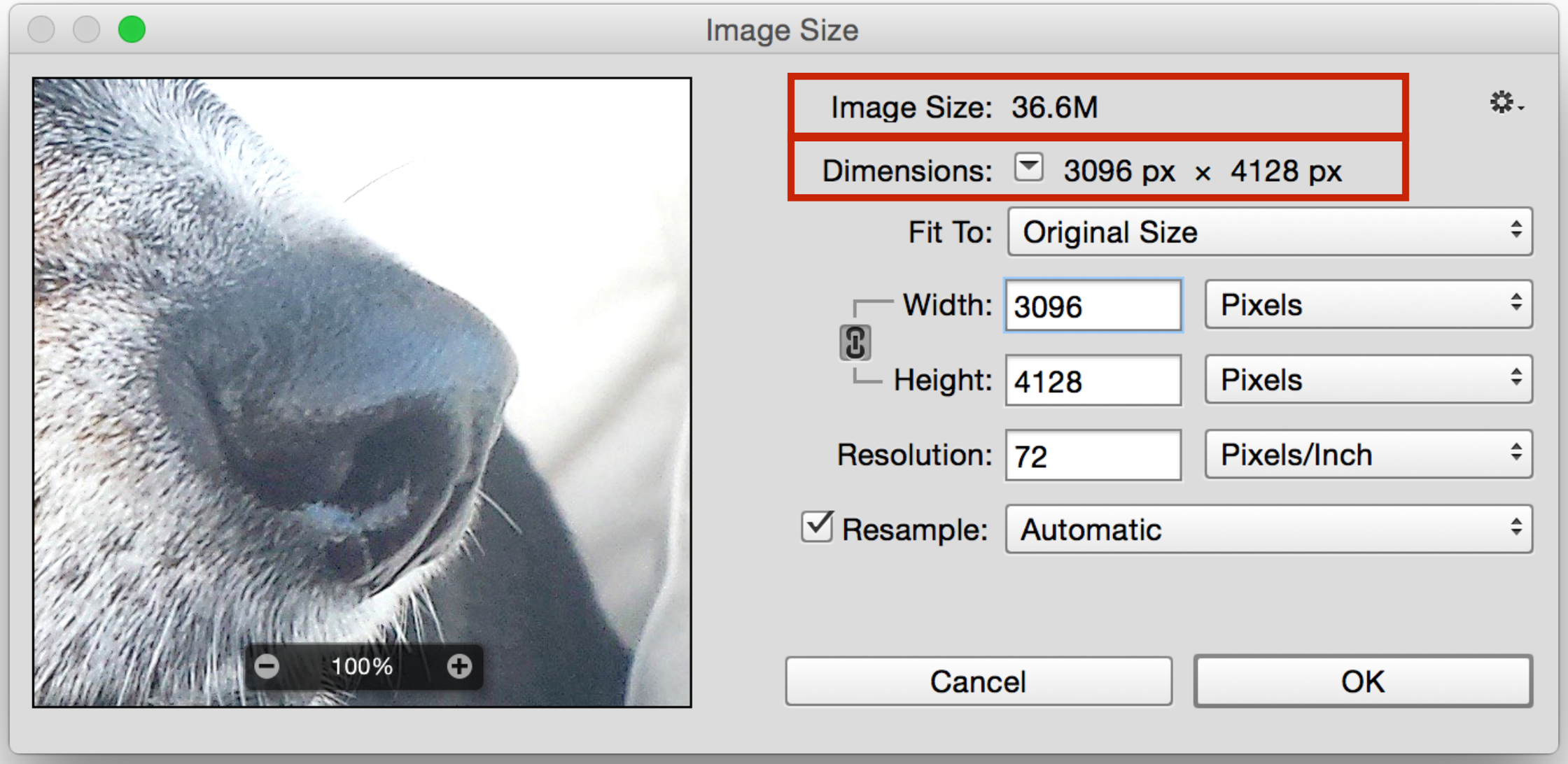
Image Size
100%
Image Size: 36.6M
Dimensions: 3096 px × 4128 px
Fit To: Original Size
Width: 3096 Pixels
Height: 4128 Pixels
Resolution: 72 Pixels/Inch
Resample: Automatic
Cancel
OK
different screen views
original file data stays the same
Image Size
12.5%
Image Size: 36.6M
Dimensions: 3096 px × 4128 px
Fit To: Original Size
Width: 3096 Pixels
Height: 4128 Pixels
Resolution: 72 Pixels/Inch
Resample: Automatic
Cancel
OK

Anatomy of Photoshop Image Size dialogue box



This means that the image's native dimensions are 3096px wide by 4128px tall *with a pixel density of 72ppi*.

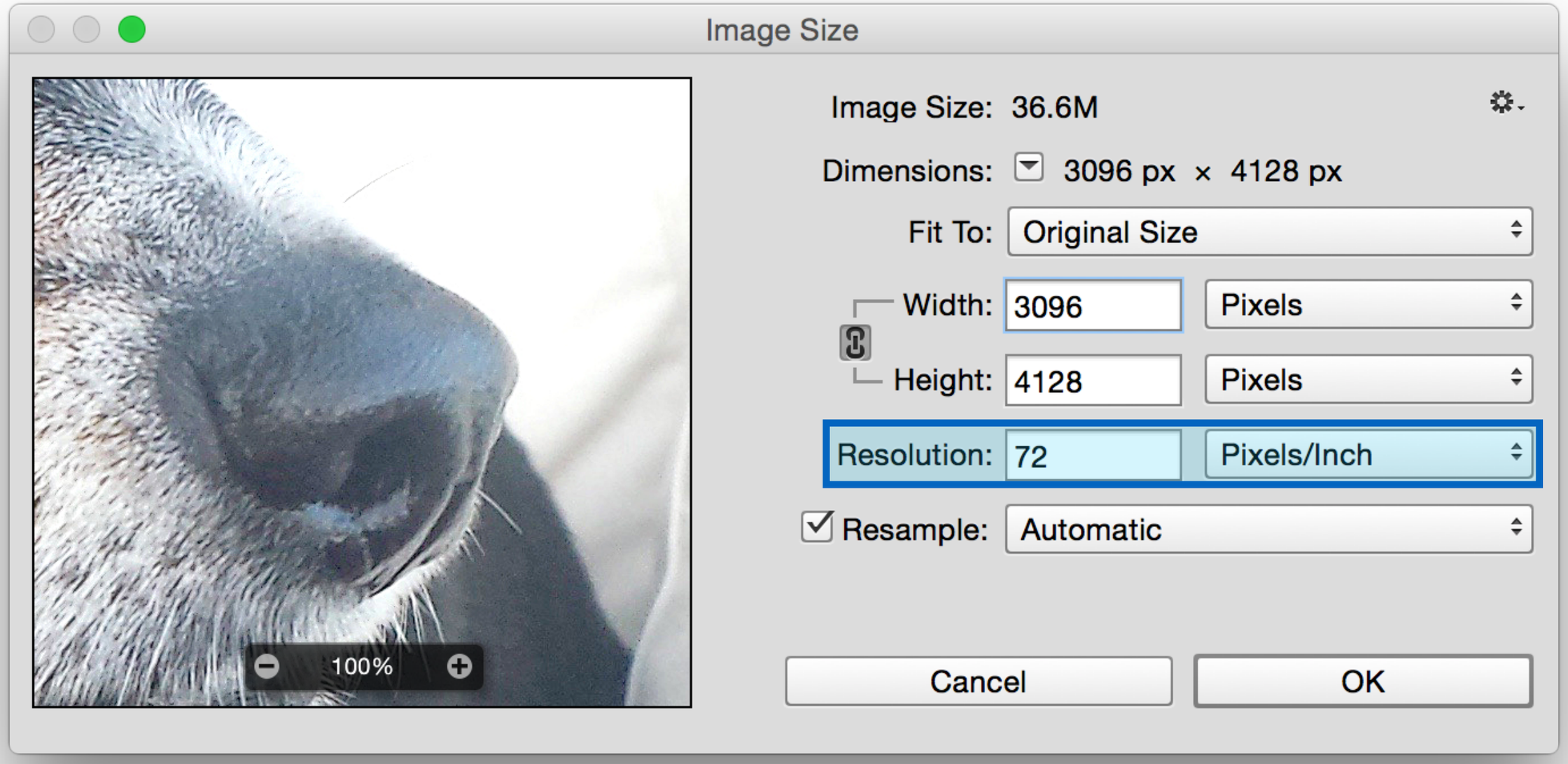
Total pixels in this file = 12,780,288 pixels



To understand the vast number of pixels that comprise an image, you can **multiply the width x height**. The larger the dimensions are, the higher the quality and file size are.

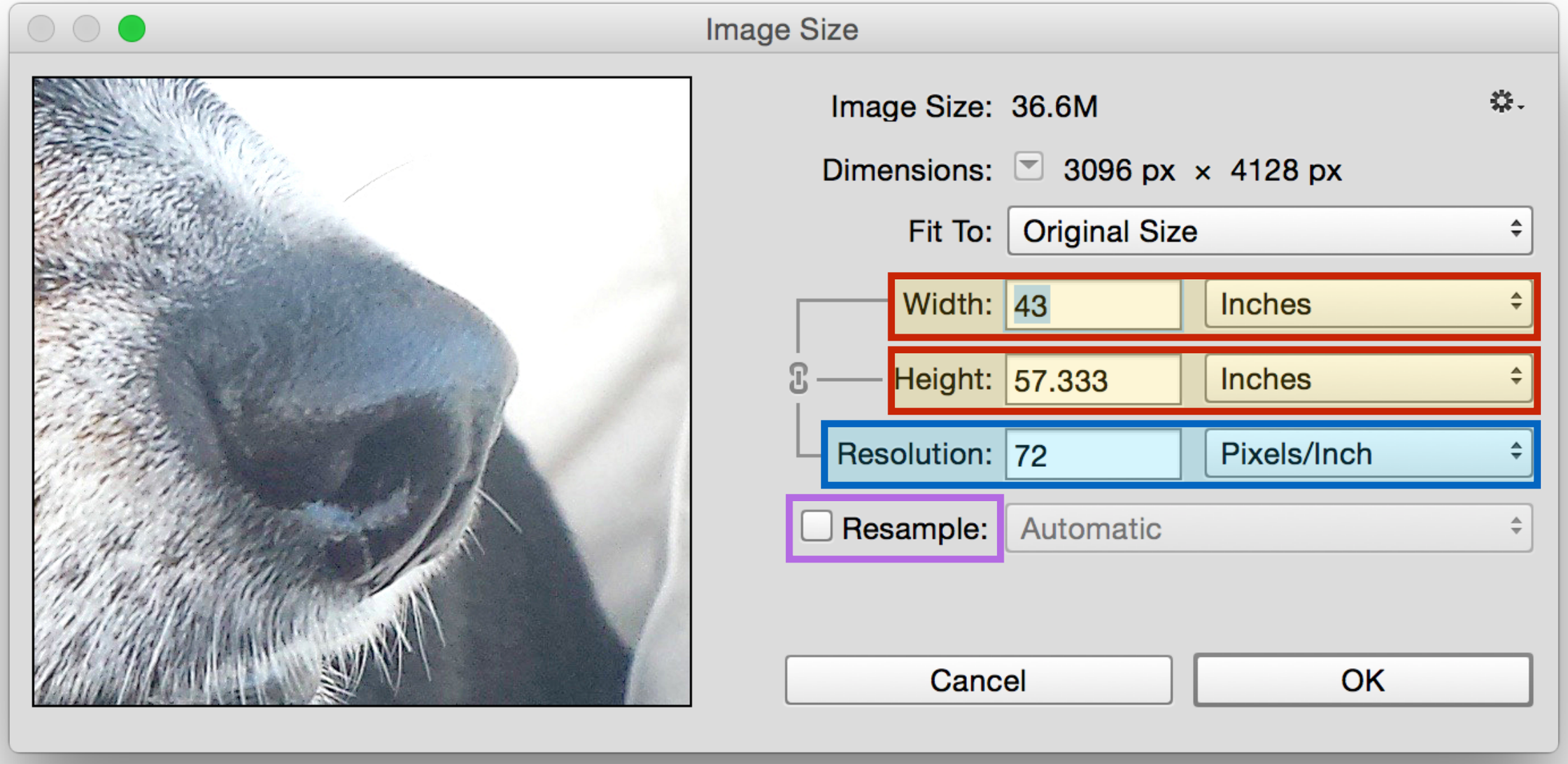
File size = Image Size in this dialogue.

Understanding **SCREEN** resolution



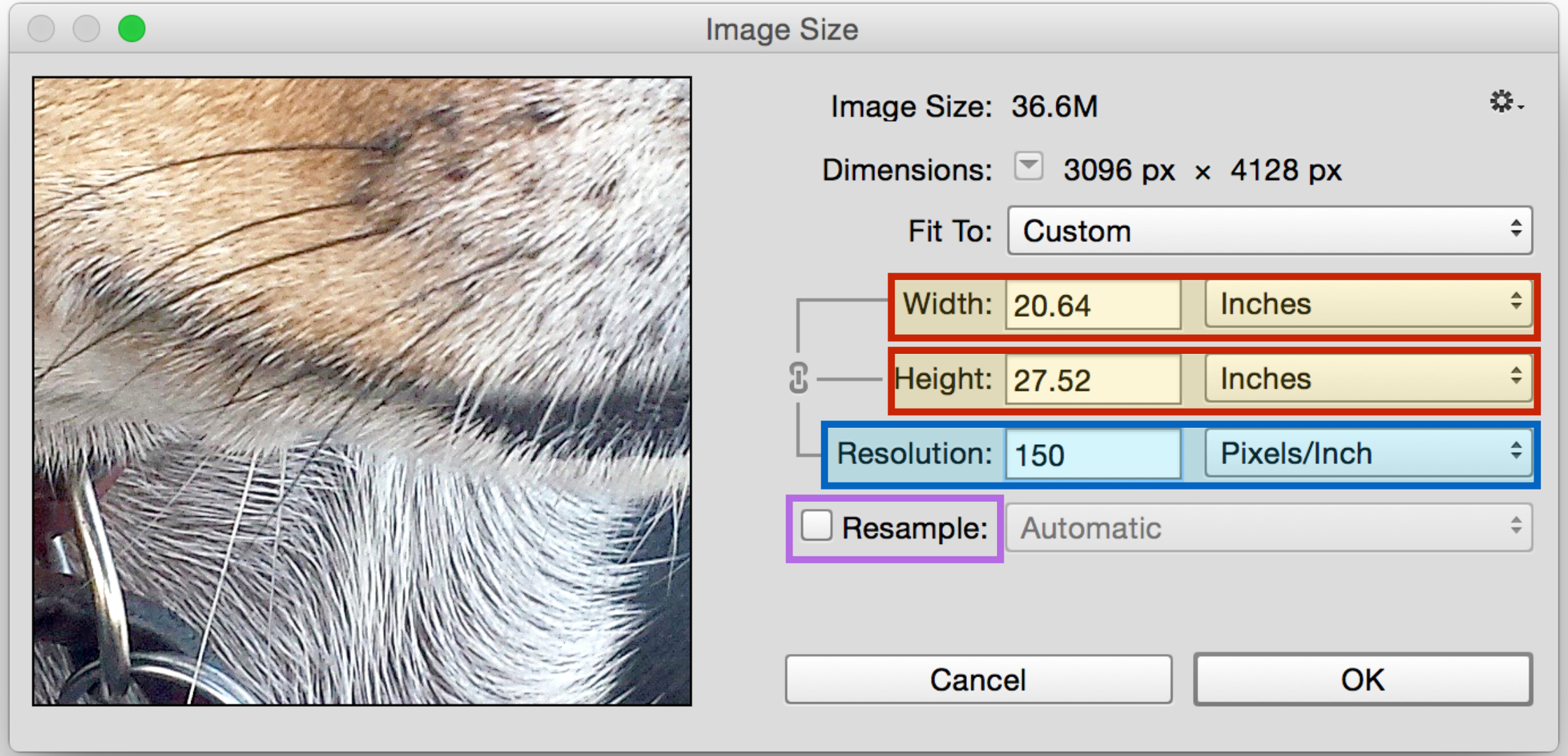
Digital displays use a screen resolution of **72ppi** because that is the maximum number of pixels that a screen can physically display per unit of area.

Screen resolution is NOT acceptable for print



Notice in this screen that "Resample" is deselected. This constrains the resolution to the print dimensions of the file so that no file data is lost or distorted.

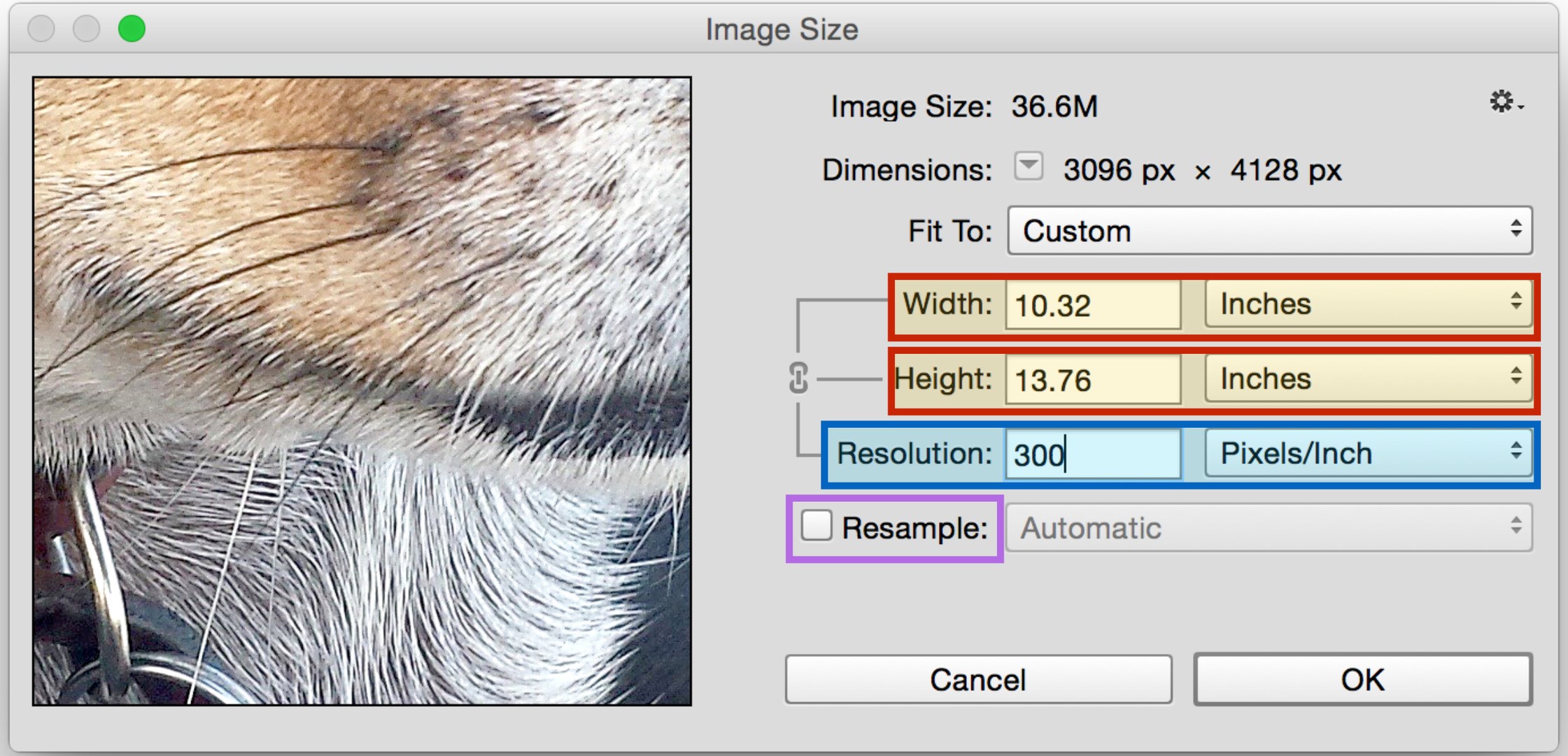
An acceptable lower-quality ppi for print ~150ppi



Notice that the dimensions and Image size are the same. No quality was lost.

BUT, notice that when we doubled the ppi, the print size inversely decreased by half.

An acceptable high-quality ppi for print ~300ppi



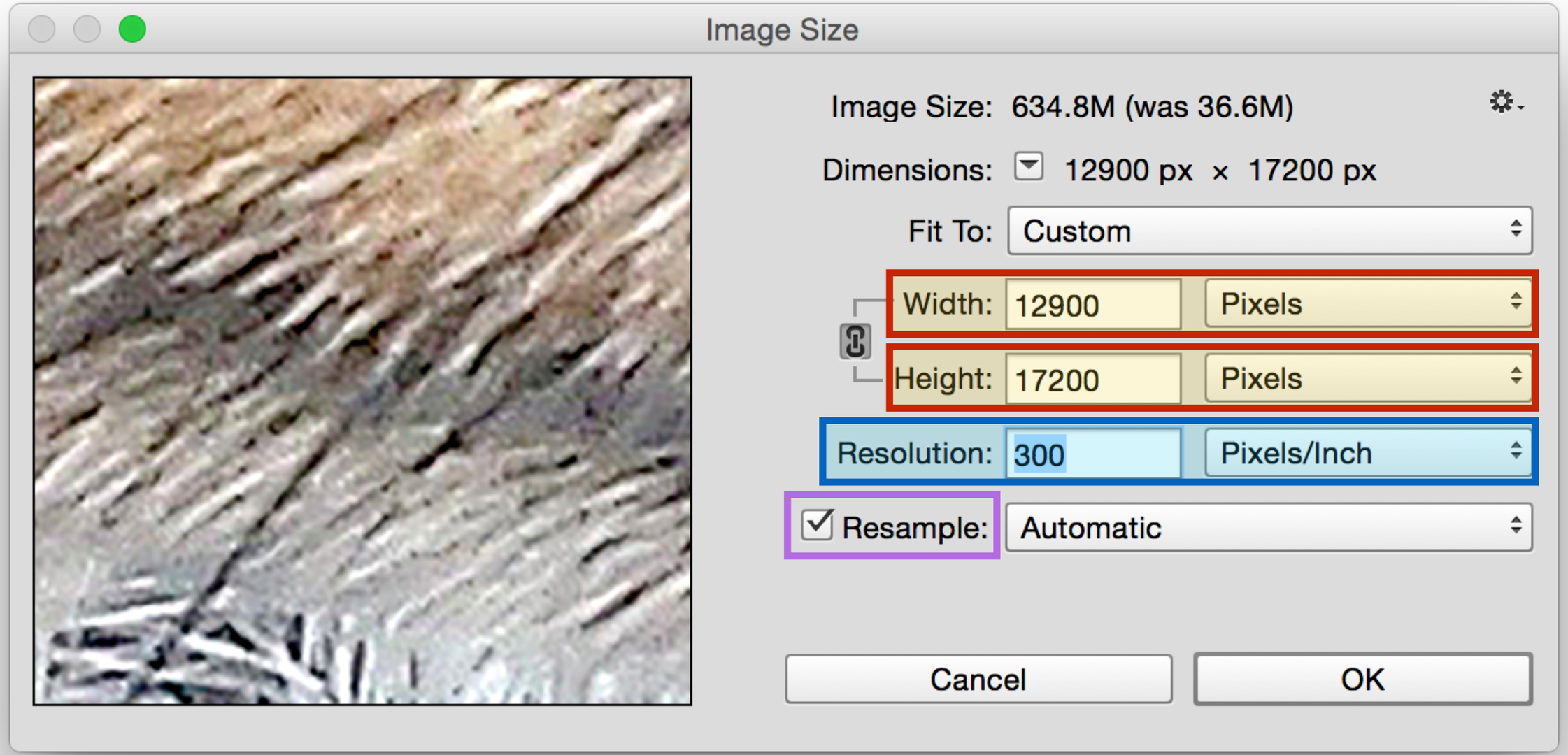
And again…

We doubled the ppi from 150 to 300, and the print size inversely decreased by half *again*.

This is called non-destructive resolution scaling because no pixel data is lost in the physical image dimensions.

If, however, you change resolution while resampling….

Leaving "Resample" checked WILL **change** data.



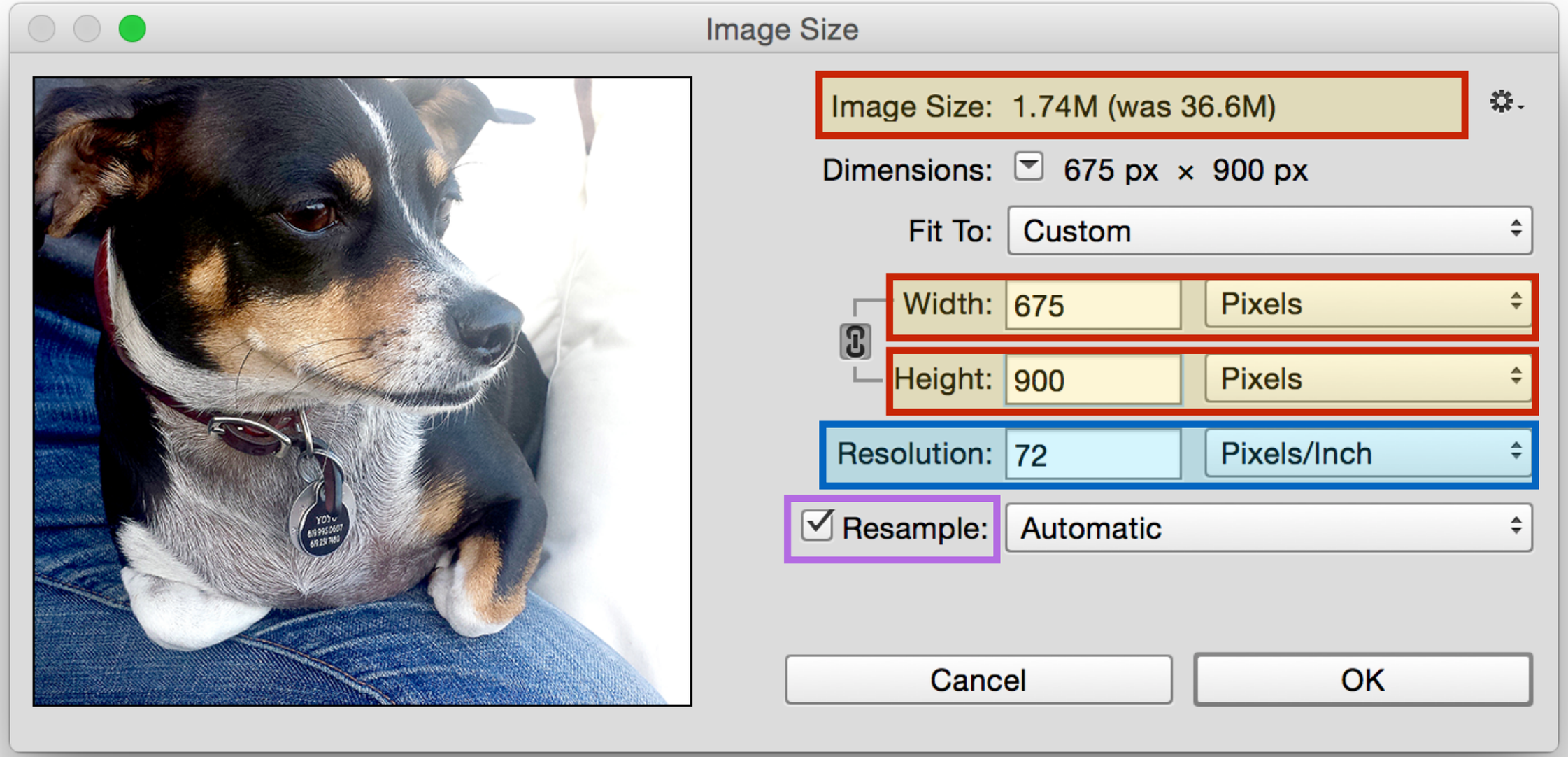
In this case, by selecting "Resample" and increasing the resolution, we have artificially added pixel data where it did not really exist, thus making a giant, poor quality image.

Over-sampling is like stretching a spring too far.

The original spring has integrity, but like a spring that has been "sprung," images that have artificial increases create missing data gaps.

Alternatively, let’s see how resampling can reduce dimensions and file size.

Leaving "Resample" checked WILL **change** data.



In this case we are leaving the resolution at 72ppi for screen presentation, but if we want it to have a smaller file size and don’t mind "throwing away" a lot of its data, we can make the pixel dimensions smaller.

Bit Depth

another thing affecting file size and properties

What is a bit?

A bit is a binary decision.

It is the smallest unit of measure for a digital file.

Yes / No
On / Off
True / False

Here is an example of a file that could be 1 bit.

Notice how it has only two values:

Black
White

Or you can think of it like this:

Presence of full light.
/
Complete absence of light.

In math, it looks like this:

2^1

A **2-bit** file can have up to **four** values per channel.

$$2^2$$

or

2 x 2 = **4**

A **3-bit** file can have up to **eight** values per channel.

$$2^3$$

or

2 x 2 x 2 = **8**

A **4-bit** file can have up to **sixteen** values per channel.

$$2^4$$

or

2 x 2 x 2 x 2 = **16**

A **5-bit** file can have up to **thirty-two** values per channel.

$$2^5$$

or

2 x 2 x 2 x 2 x 2 = **32**

A **6-bit** file can have up to **sixty-four** values per channel.

2^6

or

2 x 2 x 2 x 2 x 2 x 2 = **64**

A **7-bit** file can have up to **one-hundred-twent-eight** values per channel.

$$2^7$$

or

2 x 2 x 2 x 2 x 2 x 2 x2 = **128**

An **8-bit** file can have up to **two-hundred-fifty-six** values per channel.

$$2^8$$

or

2 x 2 x 2 x 2 x 2 x 2 x 2 x 2 =

256

Okay, so what is a "channel" ???

Different file types have different channel possibilities, but let's start with a common one:

JPG

Standard device outputs typically don’t exceed 8-bits (or 256 possibles values) per channel, so we will focus on 8-bit files.

Standard (rgb) **color (jpg, png, tif)**

=

Red, Green, Blue

8 bits

or

256 possible red tones

X

8 bits

or

256 possible green tones

X

8 bits

or

256 possible blue tones

= millions of colors

Standard (cmyk) **color**
(tif, jpg)
=
Cyan, Magenta, Yellow, Black

8 bits

or

256 possible cyan tones

X

8 bits

or

256 possible magenta tones

X

8 bits

or

256 possible yellow tones

X

8 bits

or

256 possible black tones

= millions of colors

Transparent **PNG 32 color**

=

Cyan, Magenta, Yellow, Black

8 bits

or

256 possible red tones

X

8 bits

or

256 possible green tones

X

8 bits

or

256 possible blue tones

X

8 bits

or

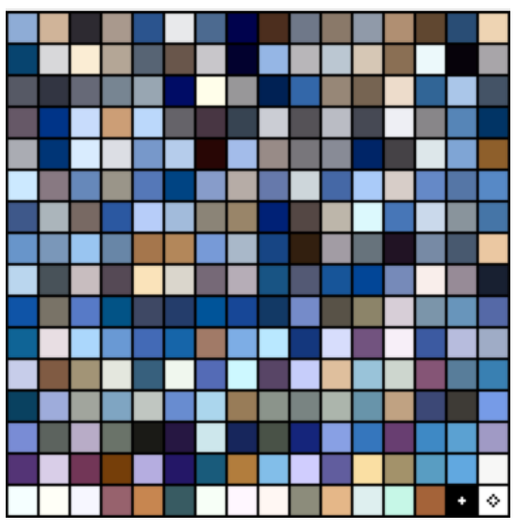
256 possible alpha levels

= millions of colors

Standard greyscale
(**lots of file types**)
=
Black

= 265 tones of light

Indexed color files
(**gif**, **png8**)
=
up to 256 mapped tones



= 265 mapped tones

Image Compression

Because file sizes can get large in spite of slow delivery methods, compressed formats exist.

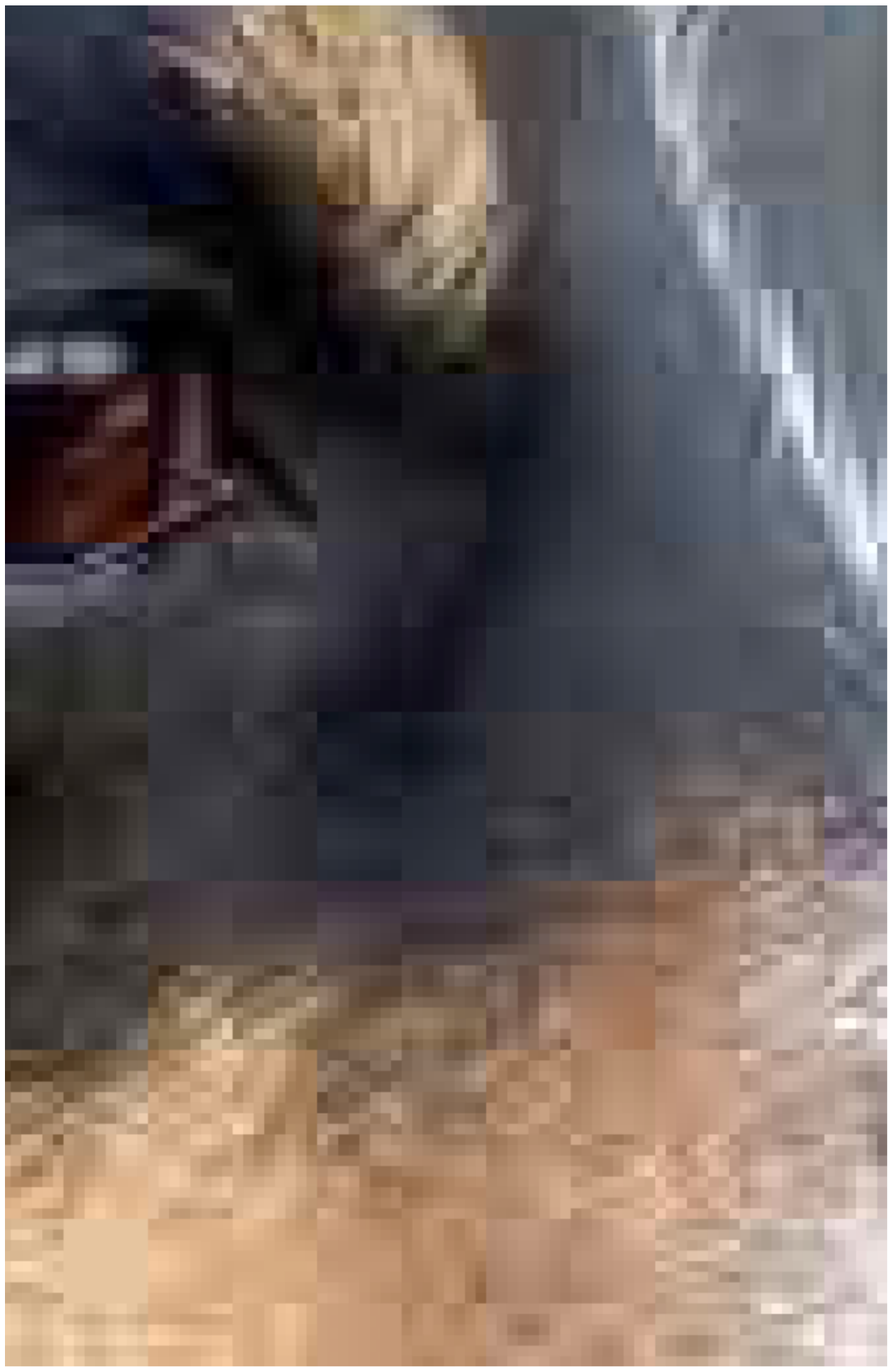
The most common one is JPG.

JPG Compression Example

High compression, low quality

JPG Compression Example

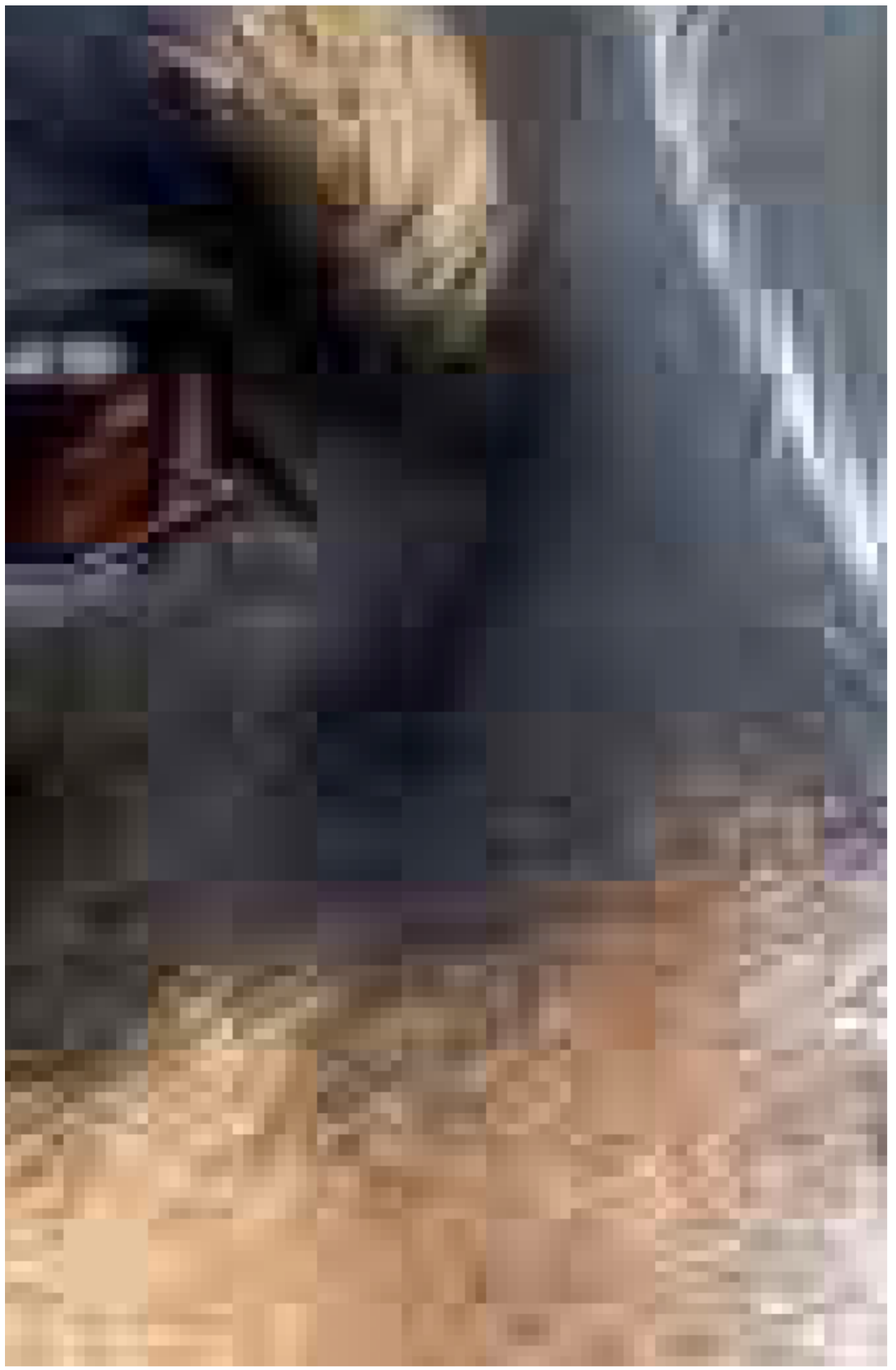
Zoomed in closer, you can start to see "artifacts" where interpolation occured.

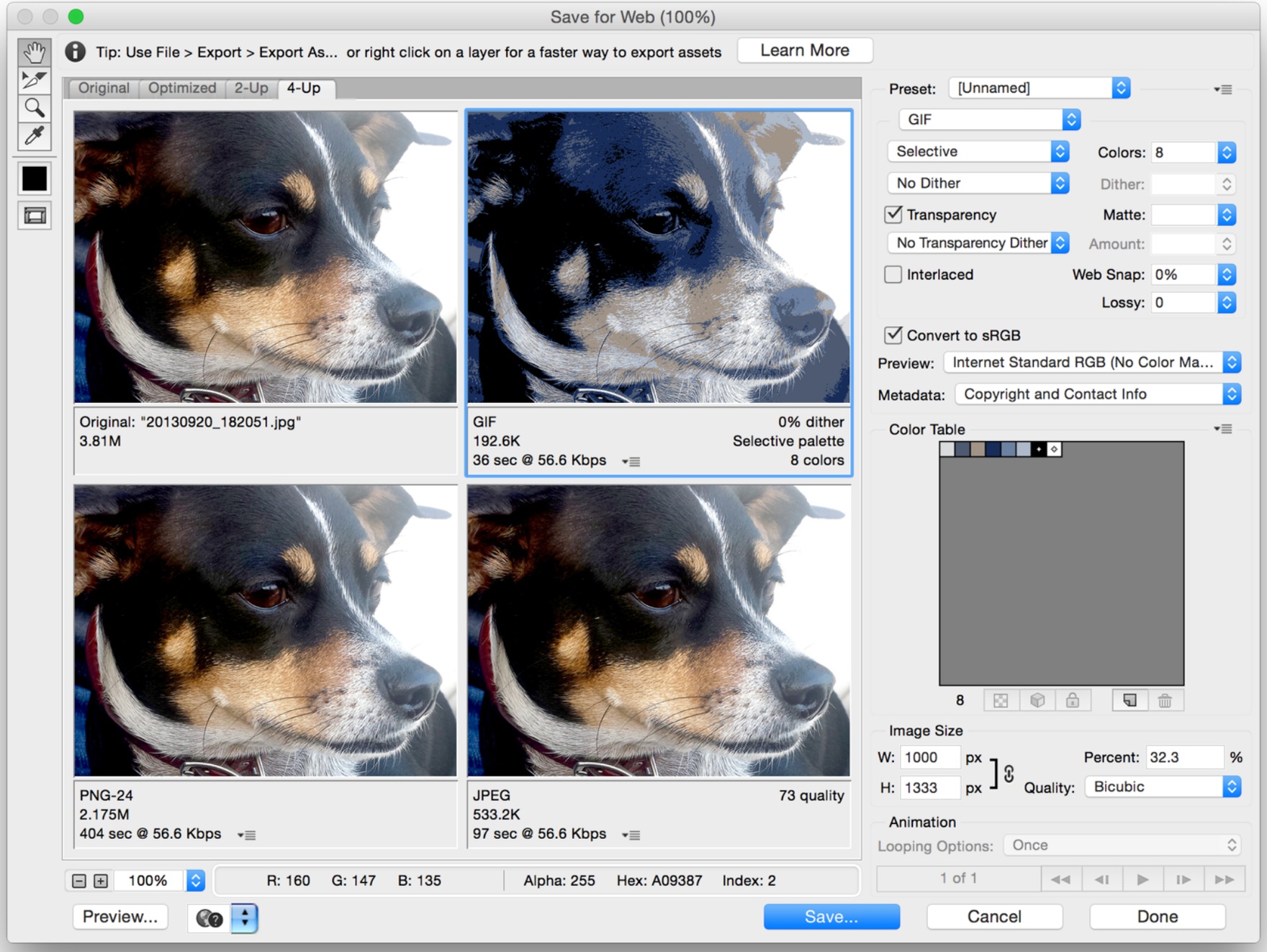


Interpolation

When a file is compressed, it throws away data, creating holes where pixels once were.

When the file is opened, the application takes an educated guess about how to recreate the missing pixels based on surrounding values.





Optimizing Images

Applications like Photoshop assist us in finding the best balance between quality and reasonable file size.