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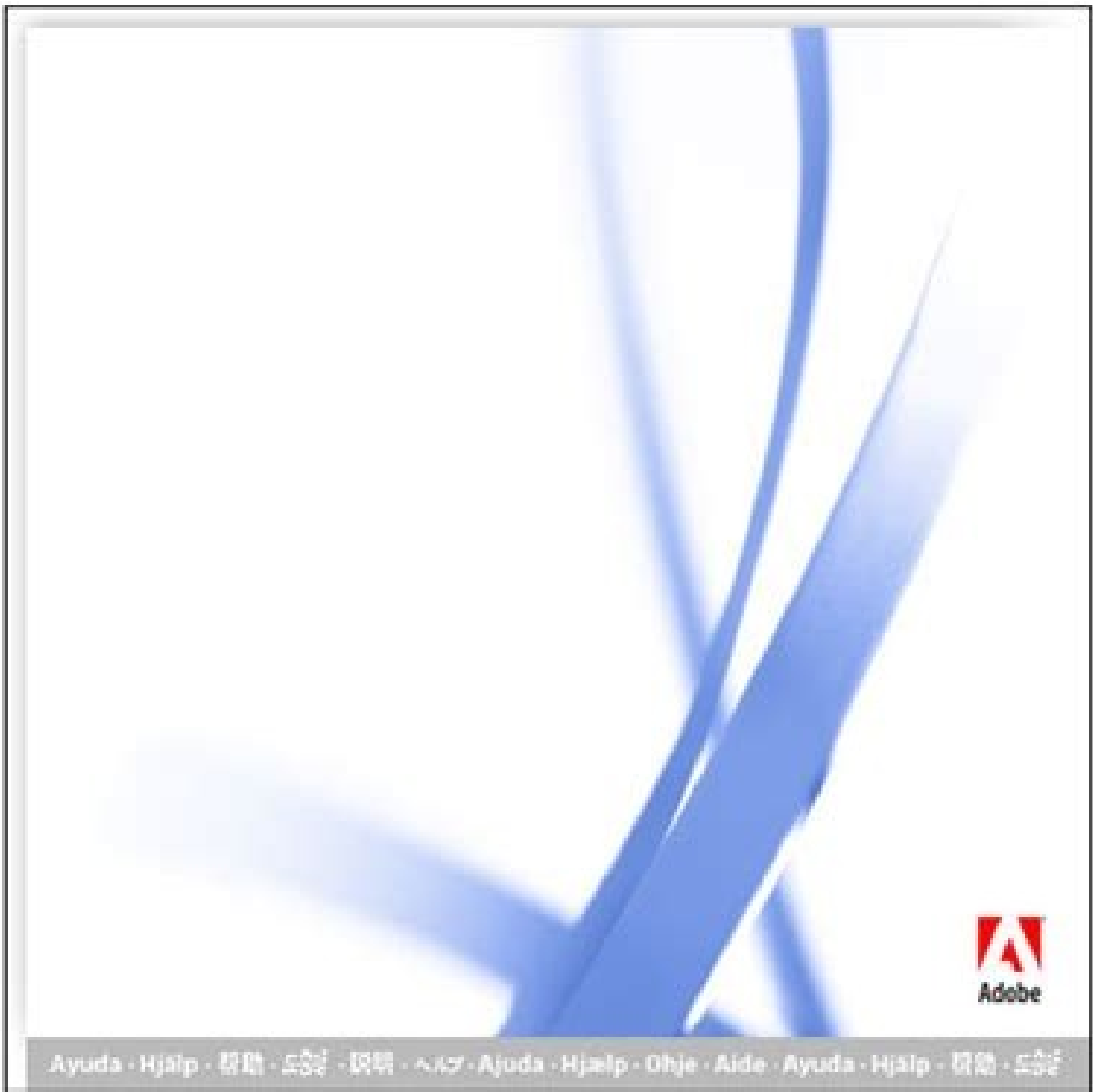
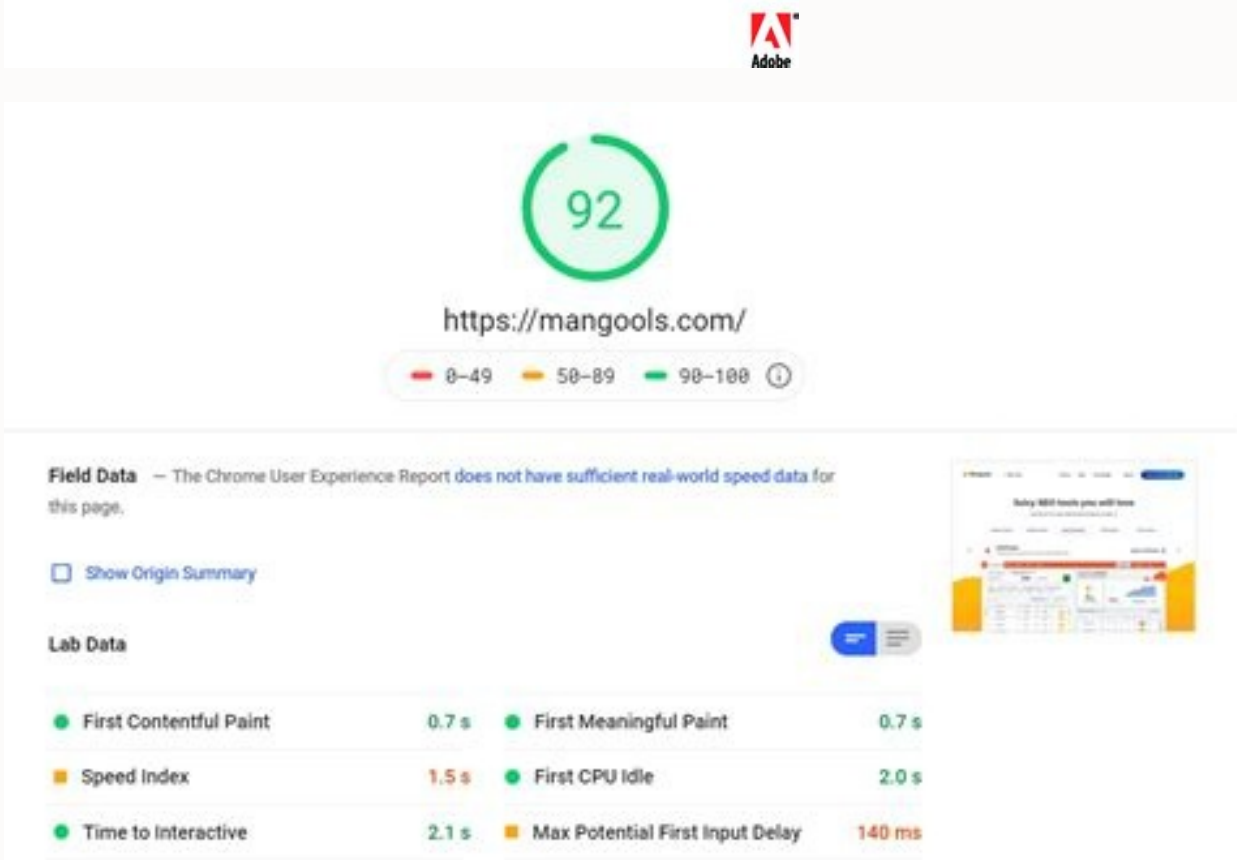
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When I set out to do these tests, I did so hoping that I'd be able to drastically reduce file size without sacrificing image quality. This is what you're doing in Photoshop when you resize using "Image" -> "Canvas Size," instead of "Image" -> "Image Size." This, of course, is a terrible outcome when we want to resize an image: we don't perceive the new outputted image to really look like the original inputted image at all; the original square is blue, the new one is blue and red. The original blue circle has two colors, blue and white. Improving web performance and giving a better experience to our users is our job as developers and designers. The average web page is 2,099 KB, 1,310 KB of which comes from images. (Image: Richard Fisher) PNGs use a type of progressive rendering called Adam7 interlacing, in which the pixels of the image are delivered in seven stages based on an 8 x 8 pixel grid. Adam7 interlacing. All else being equal, more colors in an image will make the file size bigger. Background interpolation is only possible when adding pixels (i.e. when making the image bigger or when upsampling), and even then it is essentially useless for resizing, except as a means to show where the new pixels are. Background interpolation. The total number of colors in the final image will be a combination of the colors in these three channels. Posterization can drastically reduce file size, but can also drastically change how an image looks. I'm happy to report that, using the settings described above, I was successful. On average, my recommended settings and optimizations reduced file sizes by 35% compared to Photoshop's "Save for Web". Savings compared to Photoshop Creative Cloud Condition File size: mean File size: % difference My settings, with optimization 218,274 bytes My settings, without optimization 259,852 bytes 19.05% Photoshop CC, with optimization 260,305 bytes 19.28% Photoshop CC, without optimization 299,710 bytes 35.26% My settings without optimization even beat Photoshop's output with optimization! Compared to ImageMagick's default image resizing, my recommendations resulted in file sizes that were 82% smaller on average. Savings compared to ImageMagick defaults Condition File size: mean File size: % difference My settings, with optimization 218,274 bytes My settings, without optimization 259,852 bytes 19.05% -resize 397,568 bytes 82.15% Compared to WordPress's default image resizing (which uses ImageMagick under the hood), my recommendations resulted in file sizes that were 77% smaller on average. Savings compared to WordPress Condition File size: mean File size: % difference My settings, with optimization 218,274 bytes My settings, without optimization 259,852 bytes 19.05% WordPress* 385,795 bytes 76.75%* Simulation using ImageMagick with the settings that these CMS' use by default. If you're using this module, you can add resizing using my recommended settings like this: var im = require('imagemagick'); var inputPath = 'path/to/input'; var outputPath = 'path/to/output'; var width = 300; // output width in pixels var args = [inputPath, 'filter', 'Triangle', '-define', 'filter:support=2', '-thumbnail', width, '-unsharp 0.25x0.25+8+0.065', '-dither None', '-posterize 136', '-quality 82', '-define jpeg:fancy-upsampling=off', '-define png:compression-filter=5', '-define png:compression-level=9', '-define png:compression-strategy=1', '-define png:exclude-chunk=all', '-interlace none', 'colorspace sRGB', '-strip', outputPath]; im.convert(args, function(err, stdout, stderr) { // do stuff }); Grunt! If you use Grunt as a task runner, good news: I've built a Grunt task named grunt-respimg (npm) that handles everything I've described above. A balance is needed. When I was doing my tests, the control images I created with Photoshop had a JPEG quality setting of high, or 60. Those pixels will need some color value, and the process of determining that color value is called interpolation. Compression filtering is a pre-compression step that reorganizes the image's data so that the actual compression is more efficient; I got the best results using adaptive filtering (-define png:compression-filter=5). So, it's best to turn dithering off with -dither None. This extra information could take up space without providing any benefit to our users and should usually be removed. DSSIM compares two images - in this case, my test image and a control generated by Photoshop's "Save for Web" - and generates a score. To resample our 4 x 4 blue square to 8 x 8 pixels, we need to add 48 extra pixels somewhere. When you're resampling, the algorithm for determining how the interpolation works is called a resampling filter. How do we resample a 4 x 4 pixel square to an 8 x 8 pixel grid? The first two values for the unsharp filter are the radius and sigma, respectively - in this case, both have a value of 0.25 pixels. I've found that this setting works well for me and strikes the right balance between quality and file size. You can include it in your projects with Composer by running: composer require nwtm/php-respimg Then, you can resize your images like this: require_once('vendor/autoload.php'); use nwtm\Respimg as Respimg; \$image = new Respimg(\$input, filename); \$image->smartResize(\$output, width, 0, false); \$image->writeImage(\$output, filename); Content Management Systems If you use a CMS, you might want to take advantage of these savings for the thumbnails and other resized images that get generated when users upload images. It determines pixel color by looking at a support area of neighboring pixels and produces a weighted average of their colors. This is called background interpolation, because the empty pixels are simply exposing a background color (red). (Image: Richard Fisher) (View large version) Unfortunately, ImageMagick has a bug that ruins images with transparency when dithering is used like this. Luckily for you, the hard part - figuring all of this out - is all done. A bunch of tools out there do this, including GD and GraphicsMagick, but ImageMagick strikes a good balance between power and availability in hosting environments. Although running this whopper of a command from the terminal every time you want to resize an image may be inconvenient, there are simpler options that require very little muss or fuss. bash shell Most command-line shells allow you to setup aliases and functions for complicated commands. This is just one study (and one that hasn't gone through a formal peer review process), but the results are interesting. The Triangle resampling filter is also known as bilinear interpolation, which I discussed above. In an ideal world, these two tools would produce identical results; unfortunately, that's not the case - convert has a bug that makes it ignore one of the settings I recommend using (the -define jpeg:fancy-upsampling=off setting, discussed below), so using mogrify is better. Resampling Choosing a resampling filter in ImageMagick is surprisingly complicated. Bilinear interpolation, for example, creates a weighted average of colors. A few options are available to you. If your CMS is built on PHP, you could bake the PHP stuff above into a theme or plugin. Some resizing functions (such as -sample) have a built-in resampling function that's always used, but others (such as -resize) have defaults that can be overridden with -filter. Because there are fewer pixels to store the image information, some of the pixels in this new grid will contain multiple colors; in the example below, some pixels contain both blue and white. Outputting the image in this way to the physical pixels in the real world isn't possible, though - each pixel can be only one color. An online store, for example, might have hundreds or thousands of image assets, and having to create different sizes of each of these is an enormous task. ImageMagick This is where automated image resizing comes in handy. Finally, I tested both with and without image optimization. From my tests, running ImageMagick with the following settings produced the smallest results, while generally being visually indistinguishable from Photoshop's output: mogrify -path OUTPUT_PATH -filter Triangle -define filter:support=2 -thumbnail OUTPUT_WIDTH -unsharp 0.25x0.25+8+0.065 -dither None -posterize 136 -quality 82 -define jpeg:fancy-upsampling=off -define png:compression-filter=5 -define png:compression-level=9 -define png:compression-strategy=1 -define png:exclude-chunk=all -interlace none -colorspace sRGB -strip INPUT_PATH That's a lot to take in, so let's go through each bit and see what it means. Mogrify vs. Even on a fast connection, a 2 MB website can wreak havoc on your users' data plans and cost them real money. High compression doesn't change how an image looks at all and only comes at the expense of processing load (in terms of CPU usage, memory usage and processing time). If you can optimize them, though, my recommendations would change slightly: I found that slightly different -unsharp settings work better (-unsharp 0.25x0.08+8.3+0.045 versus -unsharp 0.25x0.25+8+0.065 without optimization) and that there's no need to use -strip. mogrify -path OUTPUT_PATH -filter Triangle -define filter:support=2 -thumbnail OUTPUT_WIDTH -unsharp 0.25x0.08+8.3+0.045 -dither None -posterize 136 -quality 82 -define jpeg:fancy-upsampling=off -define png:compression-filter=5 -define png:compression-level=9 -define png:compression-strategy=1 -define png:exclude-chunk=all -interlace none -colorspace sRGB INPUT_PATH A lot of different image optimizers are out there. First, the new pixel grid gets applied to the original image. In most cases, the -thumbnail function uses a three-step process to resize images: It resizes the image to five times the output size using the -sample function, which has its own built-in resampling filter that's similar to the nearest-neighbor approach discussed above. It resizes the image to its final output size using the basic -resize filter. It strips meta data from the image. This means that if we were resizing an image to be 500 pixels wide, -thumbnail would first resize it to 2,500 pixels wide using -sample; the result might be blocky and pixelated, as we saw in the examples above, but the operation would be fast and would produce a result with a small file size. I found it best to specify this support area at two pixels using the -define filter:support=2 setting. The third way to choose a resampling filter, the -interpolate setting, is ignored by -thumbnail, so it's not needed here. In addition to the settings above, by default ImageMagick also uses something called JPEG fancy upsampling, an algorithm that tries to produce better-looking JPEGs. I've found that it produces larger files and that the quality difference is negligible, so I recommend turning it off with -define jpeg:fancy-upsampling=off. Sharpening Images pretty often get a little blurry when resized, so programs such as Photoshop will often apply some sharpening afterwards to make the images a little crisper. It's also the default color space in Photoshop. However, in my ImageMagick settings, I'm recommending -quality 82. In short, sRGB is the color space of choice for the web platform, and, assuming you want your images to render predictably, using it is probably a good idea. Quality and Compression With lossy image formats such as JPEG, quality and compression go hand in hand: the higher the compression, the lower the quality and the lower the file size. There are three ways you can do this: with the resizing function you choose, with the -filter setting, or with the -interpolate setting. One of these things just doesn't belong here, but the rest look pretty much the same, which is why I used an objective quality measure. A quality of 60 in Photoshop might be the same as a quality of 40 in one program, quality B+ in another and quality fantastic in a third. One of the biggest impacts we can have is to make our websites more performant, which will improve our users' experiences and even make our content available to whole new markets. (View large version) Another very simple interpolation method is to make our new pixels the same color as their neighboring pixels; this is called nearest-neighbor interpolation. I looked at 11 different functions and found that -thumbnail does the best job of optimizing quality and file size. I tested these tools both individually and in combination, and I found that the best results come from running files through all three, in the order listed above. The idea is that even if the full, perfect image doesn't load quite as quickly, users would be able to see something earlier, and that something is probably better than nothing. Last year, though, Radware released research on progressive JPEGs that shows users actually tend to prefer sequential image rendering. Well, yes, but first we have

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