Sharpening and Noise Reduction

- **Sharpening**
  - Why sharpen?
    - Aliasing
      - All digital cameras create an image by sampling the image into rows and columns of pixels.
        - If objects in the photograph have the wrong characteristics, such as closely spaced lines, or lines nearly parallel to lines in the sensor, then the interaction between the objects in the photograph and the lines in the sensor cause harmful artifacts in the image.
        - The phenomenon causing the artifacts is called "aliasing" and predates digital photography by decades.
      - Once aliasing occurs, it can be very difficult, if not impossible, to remove.
    - Aliasing can be prevented by blurring the image slightly, thereby reducing or eliminating the artifacts. This blurring is accomplished by an anti-aliasing filter on the sensor.
      - The blurring is not selective
    - Sharpening can reduce the impact of the anti-aliasing filter.
  - Types of Sharpening
    - Capture Sharpening
      - Compensates for the anti-aliasing filter
      - If you mess up the photograph and get an image that isn't sharp enough because of poor focus, lack of depth of field, etc., attempting to fix the image with capture sharpening tools can make a bad situation worse.
      - **More is not necessarily better**
        - It is a common mistake to try to fix a soft image by applying capture sharpening. It may work up to a point, but the results are often unsatisfactory.
    - Creative Sharpening
      - Used for selectively increasing sharpness, or reducing the sharpness, of parts of the image.
        - For example, it may be useful to sharpen the eyes of a model without sharpening her other features.
    - Output Sharpening
      - Sharpens the final image for use and depends on the use of the image. Images destined for display on the computer need to be sharpened differently than images being sent to a printer.
        - Images sharpened for the printer may appear to be over-sharpened when viewed on the screen.
  - Capture Sharpening

- The sharpening controls in Lightroom and ACR are intended only for capture sharpening.
  - The print and export features within Lightroom will apply output sharpening.
- The capture sharpening in Lightroom and ACR works by creating halos to increase contrast at light/dark boundaries in the image
  - Light is made lighter, dark is made darker
- Lightroom and ACR Sliders
  - Amount
    - Described by Jeff Schewe as the volume control for the other settings.
  - Radius
    - Determines the size of the halos. Images with lots of detail require a small number here, and images that have less detail, or detail that should not be overly enhanced, should use a larger radius.
  - Detail
    - Complicated setting that only a few people on earth truly understand. Low values suppress the halos and can turn sharpening off. Higher values allow the halos to be at full strength and may be desirable for images with lots of detail.
  - Masking
    - Prevents areas that have little or no detail from being sharpened. Increasing the masking value causes less of the image to be sharpened. Sharpening can increase the amount of apparent noise, but a properly applied mask will prevent this from occurring.
  - **Make adjustments while viewing critical part of the image at 100%, or 1:1 resolution**
- Noise Reduction
  - The noise reduction settings work together with the sharpening
    - Noise reduction can help to remove noise that is enhanced by the sharpening function
    - A relatively noise-free camera at low ISOs might require little or no noise reduction. Noisy cameras and high ISOs require more noise reduction
      - Adjusting the luminance slider to values between 10 and 30 will reduce noise sufficiently in most cases. 20 is a good default
        - Use the masking slider when sharpening to prevent areas with little detail from being sharpened
    - Removing noise entirely is unnecessary and is undesirable because it will reduce sharpness
- Suggested Settings
  - **Typical Nature Images**
    - **Amount: 60**
    - **Radius: 0.5**
    - **Detail: 50**

- **Masking: 20-45**
  - Masking is best done while using the preview features in Lightroom and ACR. We will talk about this in class, but using numbers in the range of 35-45 should be okay.
- Portraits
  - Portraits require a higher radius setting because it is not desirable to sharpen blemishes and skin texture.
    - Increasing the radius requires a reduction in the amount of sharpening
    - The values below come from the Lightroom preset for portraits
    - **Amount: 30 - 40**
    - **Radius: 1.0 to 1.2, perhaps as high as 1.4**
    - **Detail: 15-25**
- Other types of images
  - Every image is different; the recommended values listed above should be considered starting points
    - Less detail in the image can allow for a higher radius, with a corresponding decrease in the amount of sharpening
- Other Software Applications
  - Sharpening is not limited to Lightroom and Photoshop. Other applications, such as Aperture and Capture One, have sharpening tools that work similarly to what is described here for Lightroom and Photoshop.
  - Because sharpening works by increasing contrast, be careful when applying other tools that work on contrast. Tools such as the "Tonal Contrast" filter in Color Efex Pro can cause symptoms similar to over sharpening. Pay attention to what these tools are doing so that you don't get into trouble.

- **Noise Reduction**
  - What causes the Noise in Digital Images?
    - Digital cameras, which include DSLRs and digicams, are all electronic devices
    - All electronic devices have noise
      - The noise may be insignificant enough to not be noticed in most cases, but it is there
      - As analog televisions have been replaced with digital televisions, the amount of noise has been reduced to where it is no longer noticeable, but it is still there
    - Engineers think in terms of the signal to noise ratio (SNR), which is just the amount of signal divided by the amount of noise
      - The higher the signal to noise ratio, the better
        - A signal to noise ratio of 1 means that the signal and noise are indistinguishable
  - High ISO Values

- Noise due to high ISO values in digital sensors is similar to grain in film. The higher the ISO, the more noise (grain) you get
  - Use the ISO you need to get the best shutter speed for your image
    - It is better to have a bit more noise if it prevents a blurry image
    - A blurry image is (almost?) always worse than a noisy one!
      - I say "almost" because I while I can't think of a case where blurry would be better, that doesn't mean there isn't one!
- Digital Imaging Sensors
  - Think of each pixel in a digital sensor as a bucket that holds electrons
  - When the camera shutter opens, incoming light, made up of photons, knocks electrons into the bucket
    - One photon causes one electron to fall into the bucket
  - When the shutter closes, the electrons are counted, and the number of electrons is converted to the brightness of the pixel
- ok, so what causes the noise
  - Electrons into the bucket
    - Some of the electrons fall into the bucket on their own (silly electrons!)
      - These electrons will be counted just as if the light had put them there, and they contribute to the noise
      - The higher the sensor temperature, the greater this type of noise
        - Sensors used for low light, i.e., astronomical, imaging are typically cooled to reduce this type of noise
- Causes of Noise in Digital Images
  - The nature of light itself
    - The light coming from the sun (or any other source) is not constant or evenly distributed
    - Light that we see as constant isn’t really, so some pixels get more light than others
  - The Electron-counting circuitry - The circuits used to count the electrons are themselves subject to noise
  - Sensor Design - Newer sensors are much less noisy than Older ones
- Types of noise
  - Luminance noise
    - Seen as variations of light and dark
    - More often seen in dark or underexposed areas
  - Color, or Chroma noise
    - Seen as variations of color
    - Can appear in highlights, shadows, or midtones
  - It can be hard to tell these apart
- What to do about it
  - It Depends

- How is the image going to be used?
  - an image taken from a high resolution sensor and scaled down to screen resolution may not show much noise
  - The same image may show noise when viewed at its maximum resolution or printed at large sizes
- Fixing Noise in your images
  - If your imaging software requires multiple steps, take care of noise reduction before sharpening
    - You don't want to sharpen the noise!!!
  - If sharpening and noise reduction are done at the same time (ACR, Lightroom, or Aperture), use appropriate masking in the sharpening to avoid sharpening the noise
    - Experiment with the noise settings to see what works best for a particular image
    - Remember that sharpening and noise reduction work at cross purposes
    - Expose to the right when possible
      - This will increase the signal to noise ratio
      - Don't do it by increasing the ISO!!!
- Fixing noise - continued
  - The best settings for one image may not be the best, or even good for another
  - The best settings are camera and iso dependent
- Noise reduction in Lightroom and ACR
  - The luminance slider is the most important one
  - Zoom in to 100 % (1:1) or more to see what is going on
  - Don't overdo it!!!
    - You will undo the sharpening
    - To much noise reduction makes the image look unnatural
  - The ideas are the same for other applications such as Aperture and Photoshop Elements
- **Reference:**
  - Much of the information in this outline is taken from *Real World Sharpening with Adobe Photoshop, Camera Raw, and Lightroom*, by Bruce Fraser and Jeff Schewe. It is an excellent source of information about sharpening and noise reduction.
- **Things to Remember**
  - **Don't try to fix an image with capture sharpening**
  - Less is more - not enough sharpening is better than too much when the sharpening becomes noticeable
  - If you can tell that an image has been sharpened, it has probably been sharpened too much.