Programming assignment

- Get used to the very basic programming environment that we will use in this tutorial. Look at the file `Ex01.cpp` in `ImageProcessingEx01.zip` with any editor. Compile it with
  `g++ Ex01.cpp NMath.cpp -I. -o Ex01`
  and run the program via
  `./Ex01`
  This will just create a copy of the image `lena.pgm` called `lenaNoisy.pgm`. You can look at images with `display`.

- Now add Gaussian noise with standard deviation 10 and 20 to the Lena image by filling in the missing code. Use the Box-Muller method, which is described below, to simulate the noise.

  The Box-Muller method creates a Gaussian distributed random variable with $\mu = 0, \sigma = 1$ given uniformly distributed random numbers. The function to generate uniformly distributed random numbers in C/C++ is `rand()`. It generates numbers between 0 and `RAND_MAX`.

  First create two independent random variables U and V with uniform distribution in [0,1].
  Then compute $N = \sqrt{-2 \ln U} \cos(2\pi V) \qquad M = \sqrt{-2 \ln U} \sin(2\pi V)$
  N and M are independent Gaussian distributed random variables with $\mu = 0, \sigma = 1$

  When saving the degraded image to disk (e.g. PGM format) ensure not to leave the interval [0,255]. Clip the values.

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Programming assignment

- Measure the PSNR of the noisy images
- Create a sequence of 50 noisy images. Average these images: $\bar{I} = \frac{1}{N} \sum_{i=1}^{N} I_i$ Measure the PSNR of the averaged image. What do you find?
- Think of a general sequence of images. Why does the above trick not work with general sequences?
- Compute the difference image of `Sidenbladh.ppm` and `SidenbladhBG.ppm`. Color images can be handled with the class `CTensor`.
- Implement the Gaussian filter, the iterated box filter, and the recursive filter. Note that you must mirror the image at the boundaries to have Neumann boundary conditions. Test these filters on `chinaToilet.pgm`. Compare their results and computation times, particularly for large amounts of smoothing.
- What about color images? Is color a problem? Run your favorite filter on `fallingMangoes.ppm`.

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