Homework 1

Task 1

a) Read a raw image

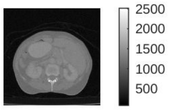
Read the image with:

- pixel size 512x512
- unsigned integer with 16 bits
- big-endian encoding

```
im_0069 = fread(fopen("data/IM_0069_rot.raw"), [512, 512], 'int16', 'ieee-be');
```

b) Display the image with a colorbar

```
figure();
imshow(im_0069, []);
colorbar
```



c) Measure the noise

Formula:

standard_deviation(image_area) / mean(image_area)

```
image_width = 614.4
```

```
image_width =
614.4000
```

```
pixel_width = 512
```

```
pixel_width =
512
```

```
pixel_size_mm = image_width / pixel_width
```

```
pixel_size_mm =
1.2000
```

```
measurement_width_mm = 24
```

```
measurement_width_mm =
24
```

```
measurement_width_pixel = measurement_width_mm / pixel_size_mm
```

```
measurement_width_pixel =
20
```

```
measurement_pos_x = 210
```

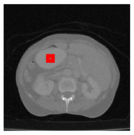
```
measurement_pos_x =
210
```

```
measurement_pos_y = 180
```

```
measurement_pos_y =
180
```

This visualization is just added to show that a homogeneous area is chosen.

```
figure();
imshow(im_0069, []);
hold on;
rectangle("Position", [measurement_pos_y, measurement_pos_x,
measurement_width_pixel, measurement_width_pixel], ...
          "EdgeColor", "r", "LineWidth", 2);
hold off;
```



```
measurement_area_im_0069 = im_0069(measurement_pos_x:measurement_pos_x
+ measurement_width_pixel, measurement_pos_y:measurement_pos_y +
measurement_width_pixel);
measurement_area_im_0069_std = std(measurement_area_im_0069(:))
```

```
measurement_area_im_0069_std =
27.1393
```

```
measurement_area_im_0069_mean = mean(measurement_area_im_0069(:))
```

```
measurement_area_im_0069_mean =
1.4275e+03
```

```
im_0069_noise_estimation = measurement_area_im_0069_std /
measurement_area_im_0069_mean
```

```
im_0069_noise_estimation =
0.0190
```

Task 2

a + b) Implement subsampling to 256x256

```
subsampled_im_size_x = 256;
subsampled_im_size_y = 256;
```

First approach

```
tic;
subsampled_im_0069 = zeros(subsampled_im_size_x, subsampled_im_size_y);
for x = 1:subsampled_im_size_x
    for y = 1:subsampled_im_size_y
        pixel_sample = [im_0069(x * 2 - 1, y * 2 - 1), im_0069(x * 2 - 1, y
* 2), im_0069(x * 2, y * 2 - 1), im_0069(x * 2, y * 2)];
        subsampled_im_0069(x, y) = mean(pixel_sample);
    end
end
toc;
```

```
Elapsed time is 0.036977 seconds.
```

Second approach

```
tic;
subsampling_index_x = 1:2:size(im_0069, 1);
subsampling_index_y = 1:2:size(im_0069, 2);
subsampled_im_0069 = (im_0069(subsampling_index_x, subsampling_index_y)
+ im_0069(subsampling_index_x + 1, subsampling_index_y)
+ im_0069(subsampling_index_x, subsampling_index_y + 1) +
im_0069(subsampling_index_x + 1, subsampling_index_y + 1)) / 4;
toc;
```

```
Elapsed time is 0.004307 seconds.
```

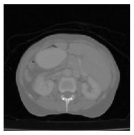
Time measurements

As expected, the second approach is much faster.

In one example run, approach one took 40 milliseconds while appraoch two finished after 4 milliseconds.

c) Display the subsampled image

```
figure();
imshow(subsampled_im_0069, []);
```



d)

```
measurement_width_subsampled_pixel = measurement_width_pixel / 2
```

```
measurement_width_subsampled_pixel =
10
```

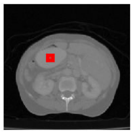
```
measurement_pos_subsampled_x = measurement_pos_x / 2
```

```
measurement_pos_subsampled_x =
105
```

```
measurement_pos_subsampled_y = measurement_pos_y / 2
```

```
measurement_pos_subsampled_y =
90
```

```
figure();
imshow(subsampled_im_0069, [])
hold on;
rectangle("Position", [measurement_pos_subsampled_y,
measurement_pos_subsampled_x, measurement_width_subsampled_pixel,
measurement_width_subsampled_pixel], ...
          "EdgeColor", "r", "LineWidth", 2);
hold off;
```



```
measurement_area_subsampled_im_0069 =
subsampled_im_0069(measurement_pos_subsampled_x:measurement_pos_subsampled_x
+ measurement_width_subsampled_pixel,
measurement_pos_subsampled_y:measurement_pos_subsampled_y +
measurement_width_subsampled_pixel);
measurement_area_subsampled_im_0069_std =
std(measurement_area_subsampled_im_0069(:))
```

```
measurement_area_subsampled_im_0069_std =
14.2814
```

```
measurement_area_subsampled_im_0069_mean =
mean(measurement_area_subsampled_im_0069(:))
```

```
measurement_area_subsampled_im_0069_mean =
1.4269e+03
```

```
subsampled_im_0069_noise_estimation =
measurement_area_subsampled_im_0069_std /
measurement_area_subsampled_im_0069_mean
```

```
subsampled_im_0069_noise_estimation =
0.0100
```

e) Caculate the noise reduction effect

(noise_original - noise_subsampled)/noise_original

```
noise_reduction_ratio = (im_0069_noise_estimation -
subsampled_im_0069_noise_estimation) / im_0069_noise_estimation
```

```
noise_reduction_ratio =
0.4736
```