CS 543

Assignment 2: Scale-space blob detection

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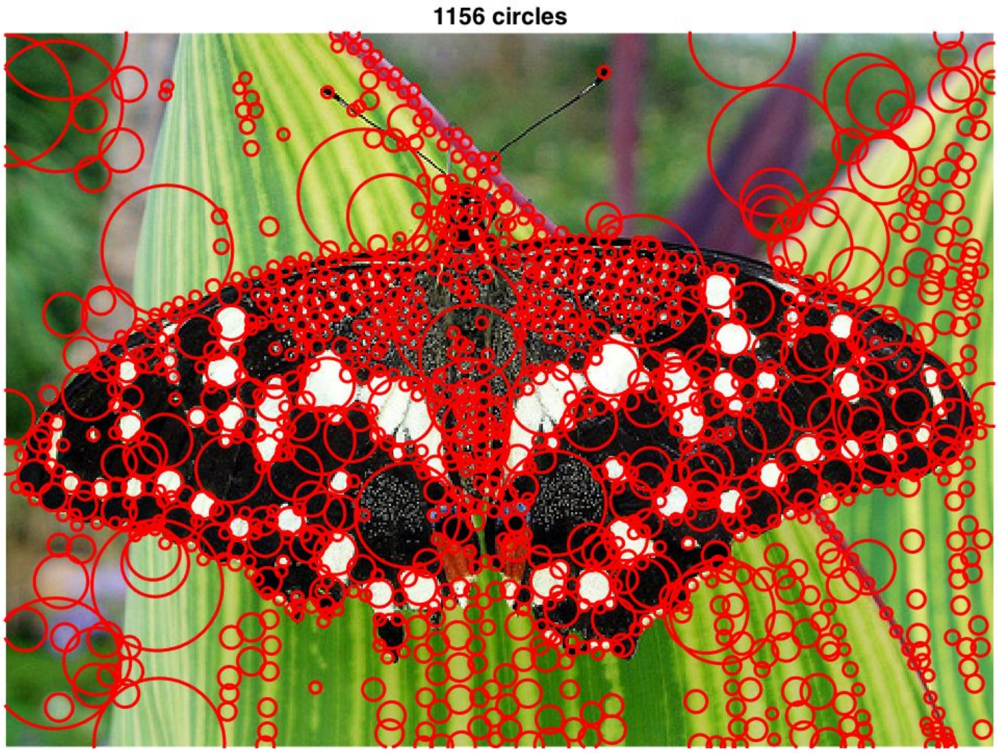
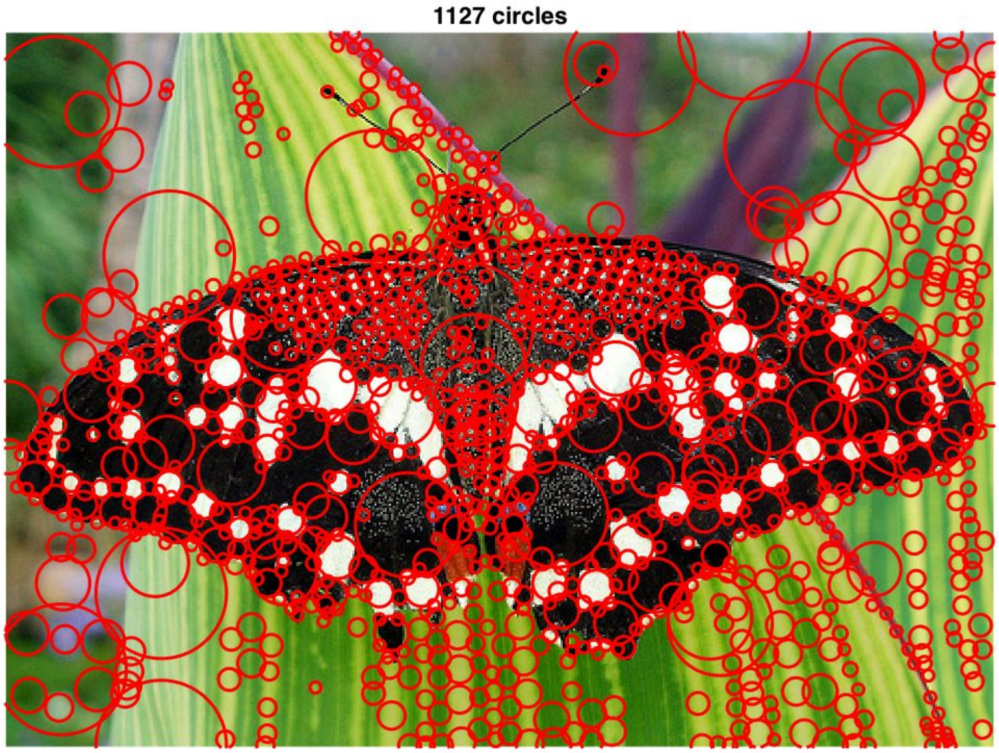
1. The output of your circle detector on all the images (four provided and four of your own choice), together with running times for both the "efficient" and the "inefficient" implementation.

(SP stands for the efficient downsample/upsample implementation while FIL stands for the inefficient filter-resizing one.)

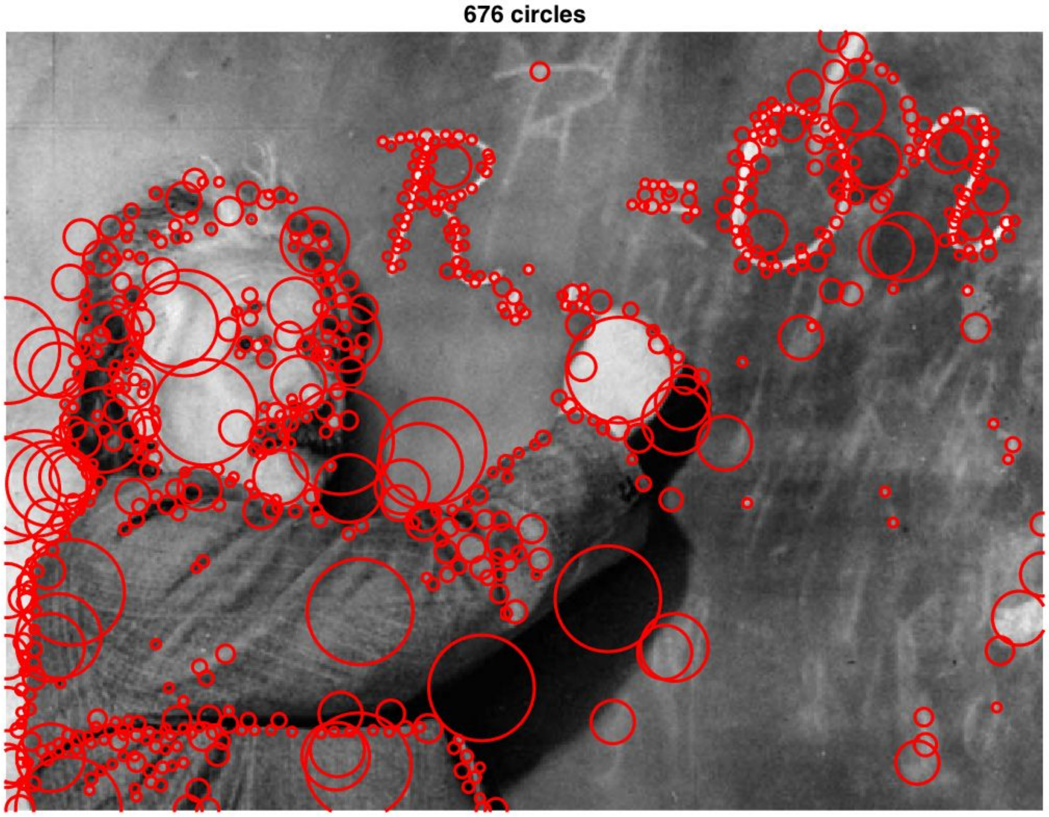
For butterfly.jpg with mode SP, it takes:
Elapsed time is 0.592462 seconds.



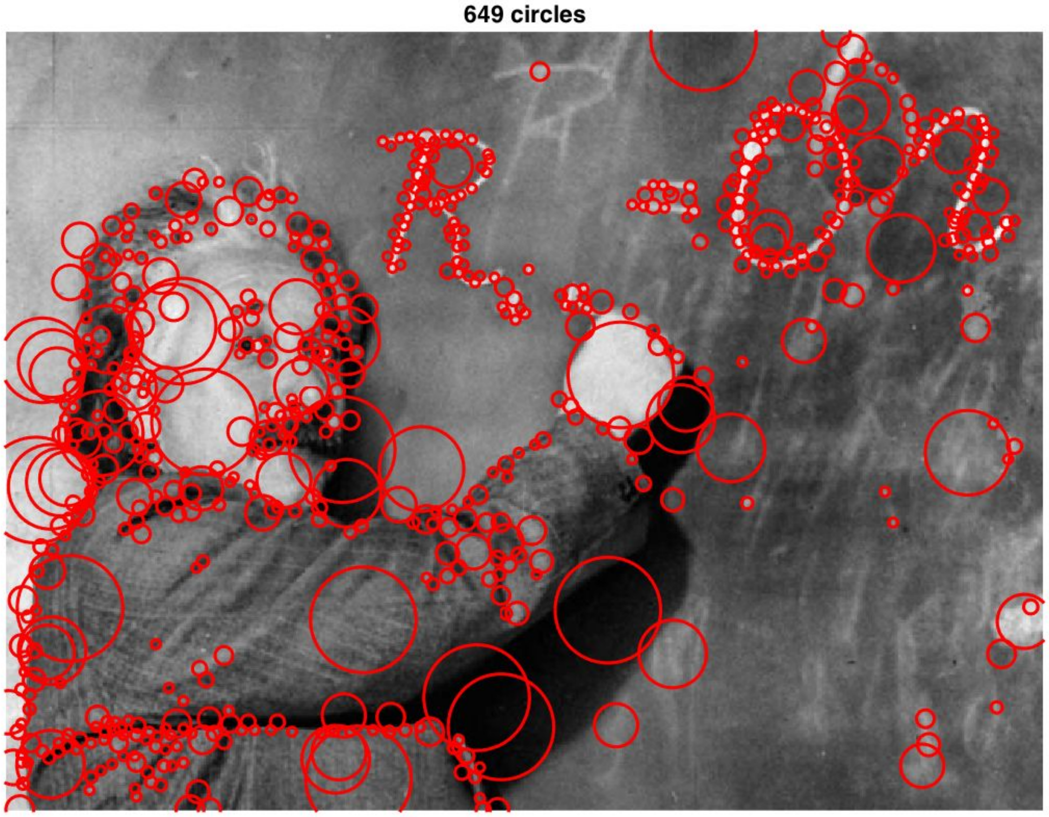
For butterfly.jpg with mode FIL, it takes:
Elapsed time is 1.659432 seconds.



For einstein.jpg with mode SP, it takes:
Elapsed time is 1.043819 seconds.

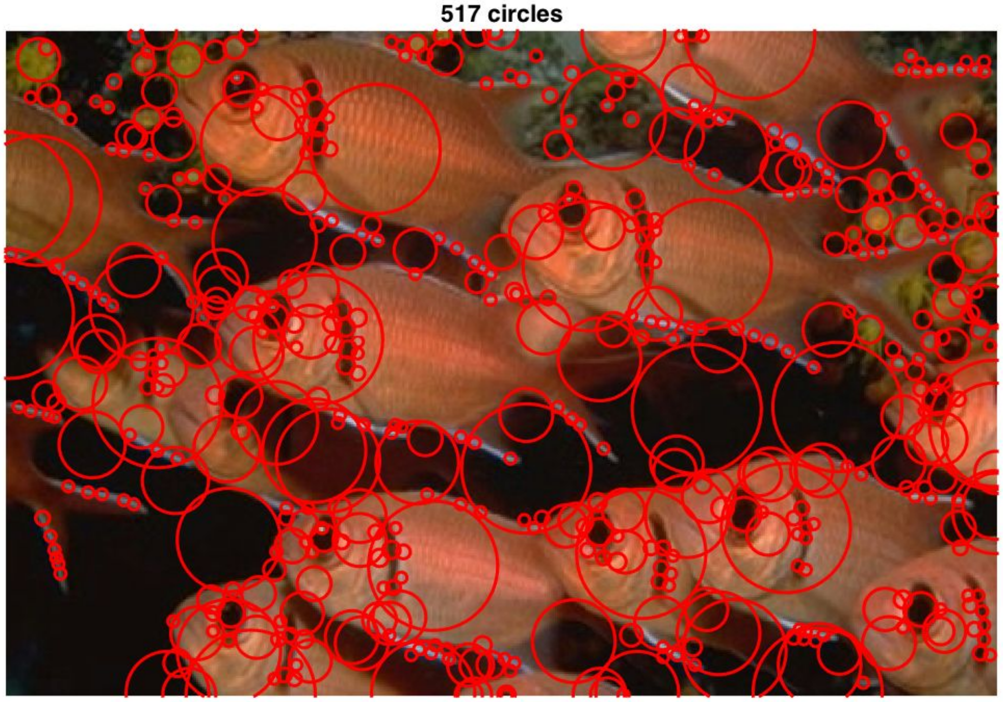


For einstein.jpg with mode FIL, it takes:
Elapsed time is 2.942673 seconds.

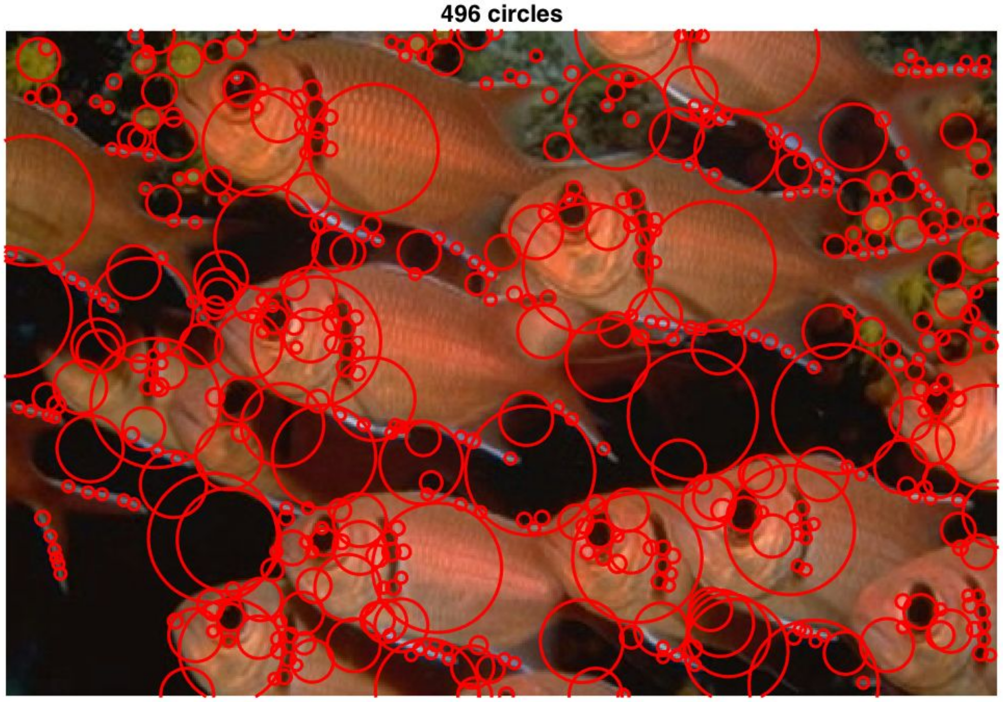


649 circles

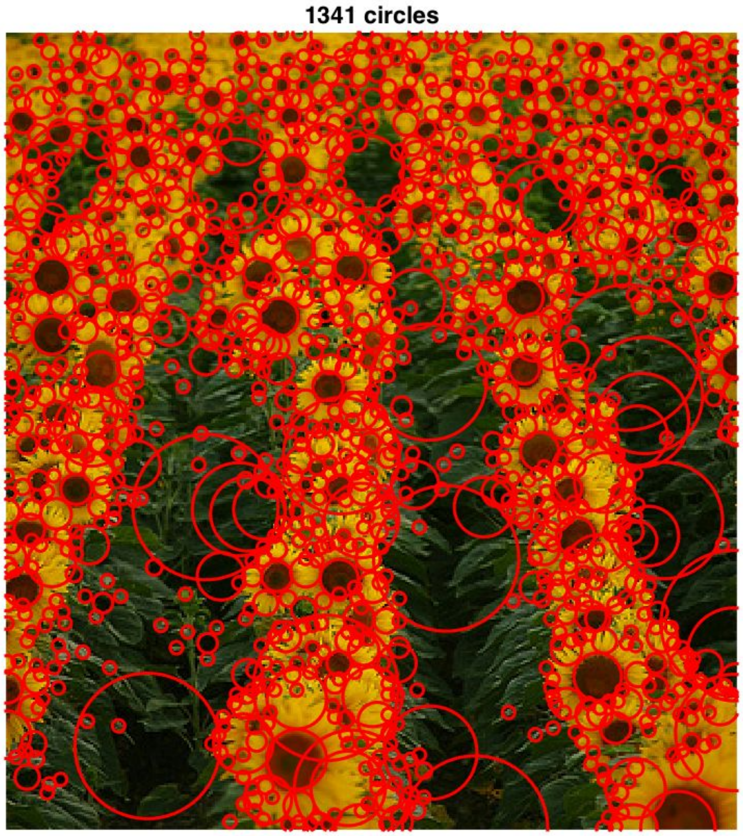
For fishes.jpg with mode SP, it takes:
Elapsed time is 0.531278 seconds.



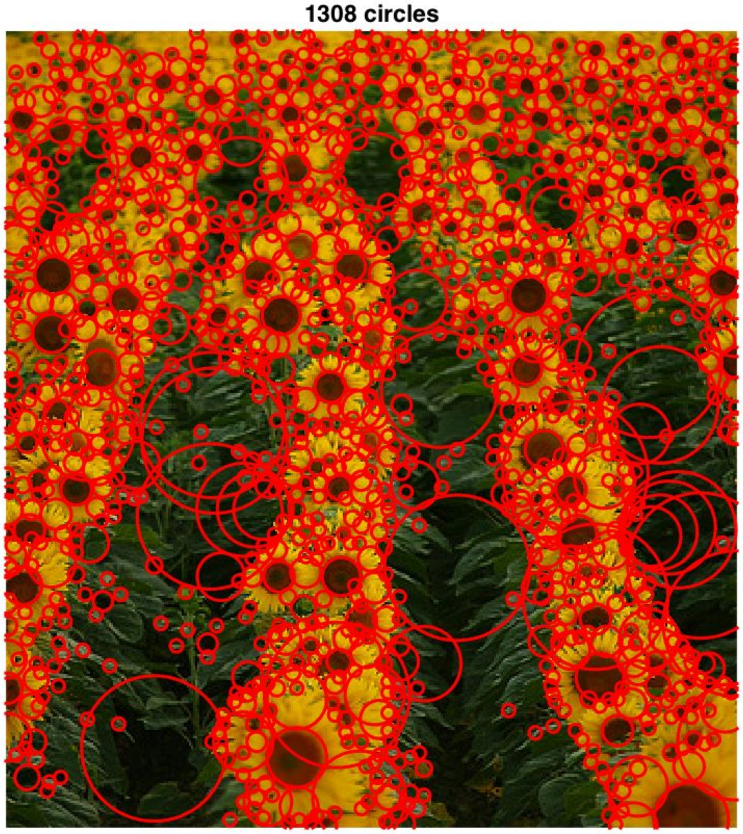
For fishes.jpg with mode FIL, it takes:
Elapsed time is 1.744661 seconds.



For sunflowers.jpg with mode SP, it takes:
Elapsed time is 0.374414 seconds.

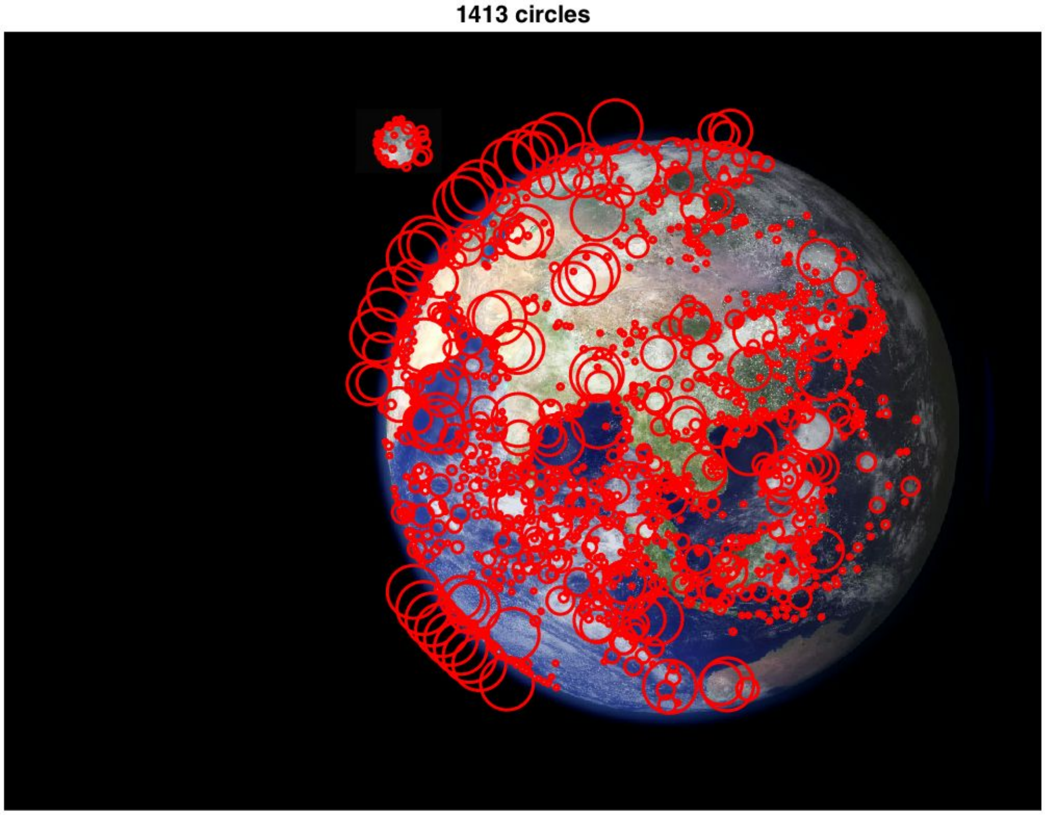


For sunflowers.jpg with mode FIL, it takes:
Elapsed time is 1.320754 seconds.

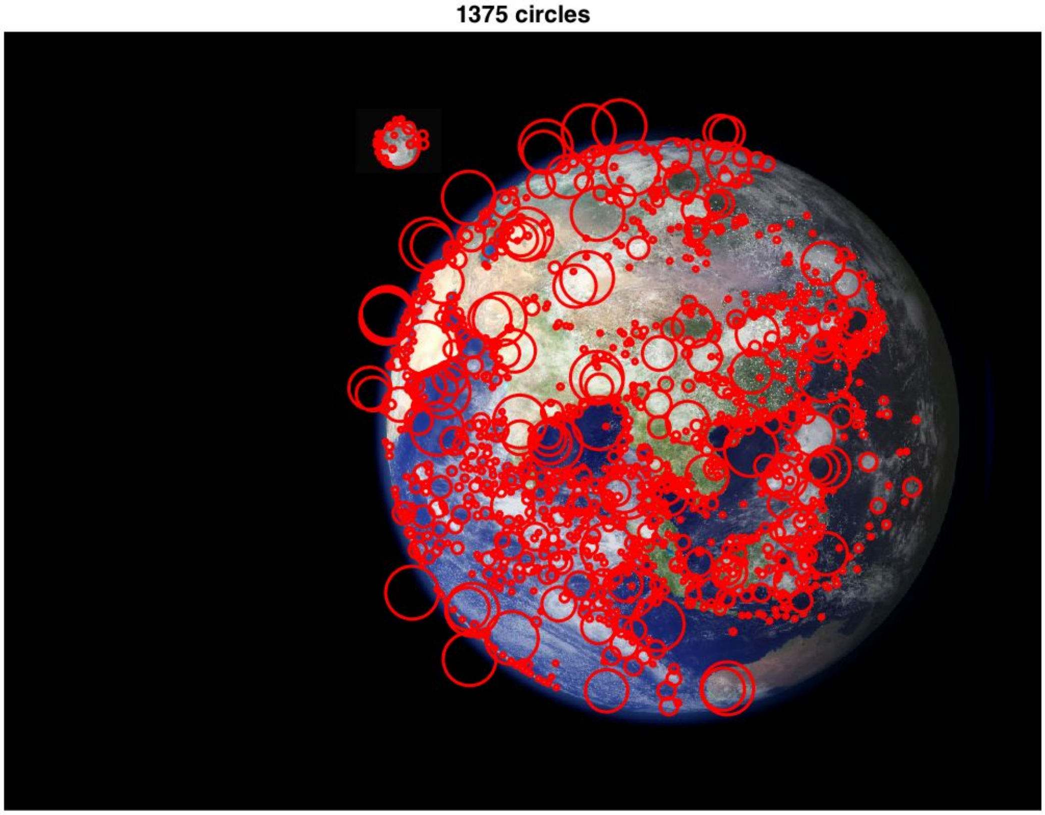


1308 circles

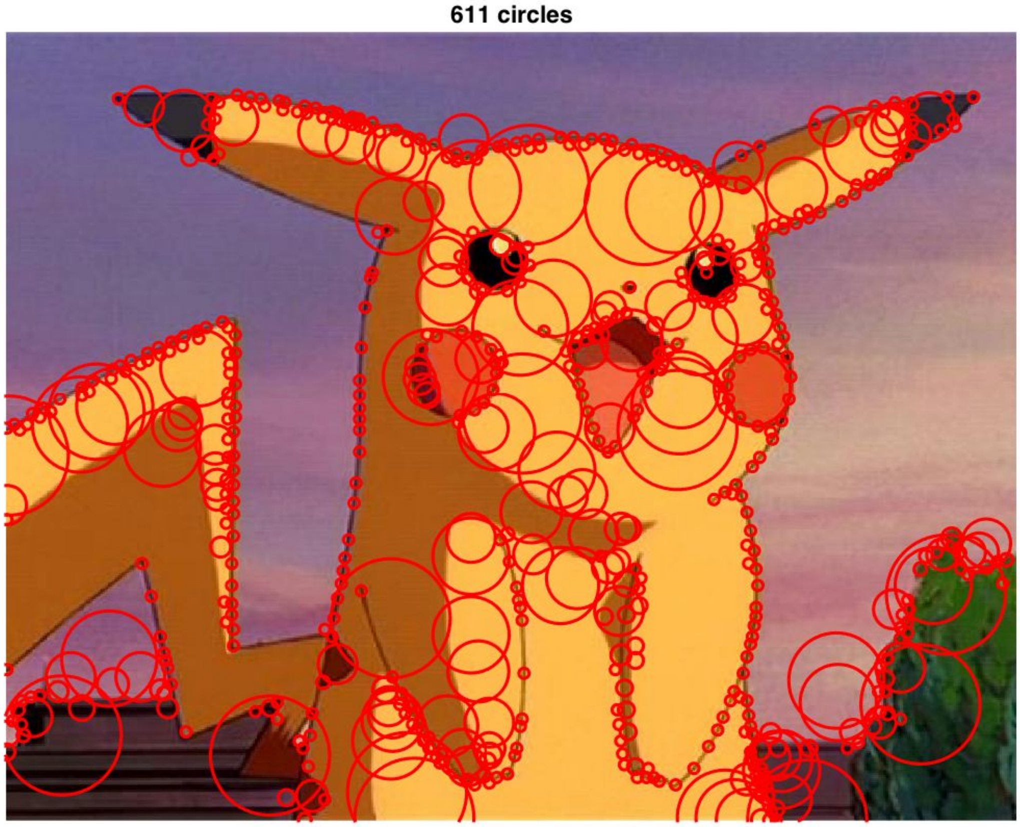
For earth.jpg with mode SP, it takes:
Elapsed time is 3.067029 seconds.



For earth.jpg with mode FIL, it takes:
Elapsed time is 11.175595 seconds.

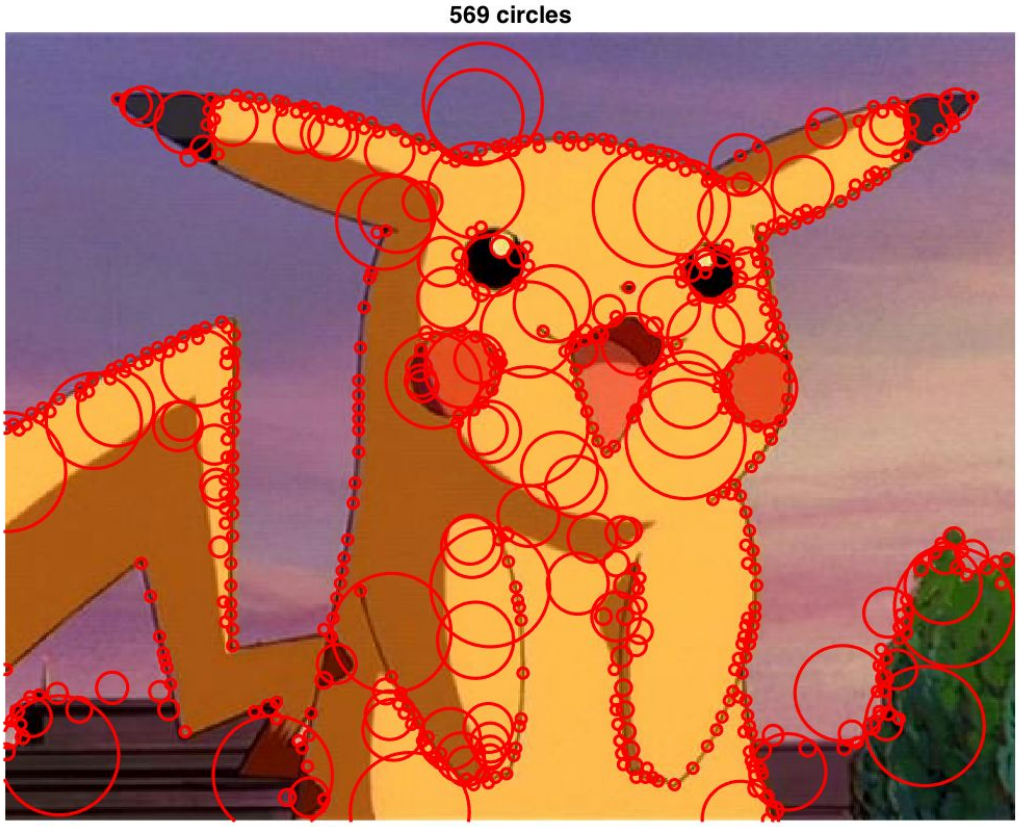


For pikachu.jpg with mode SP, it takes:
Elapsed time is 0.751333 seconds.

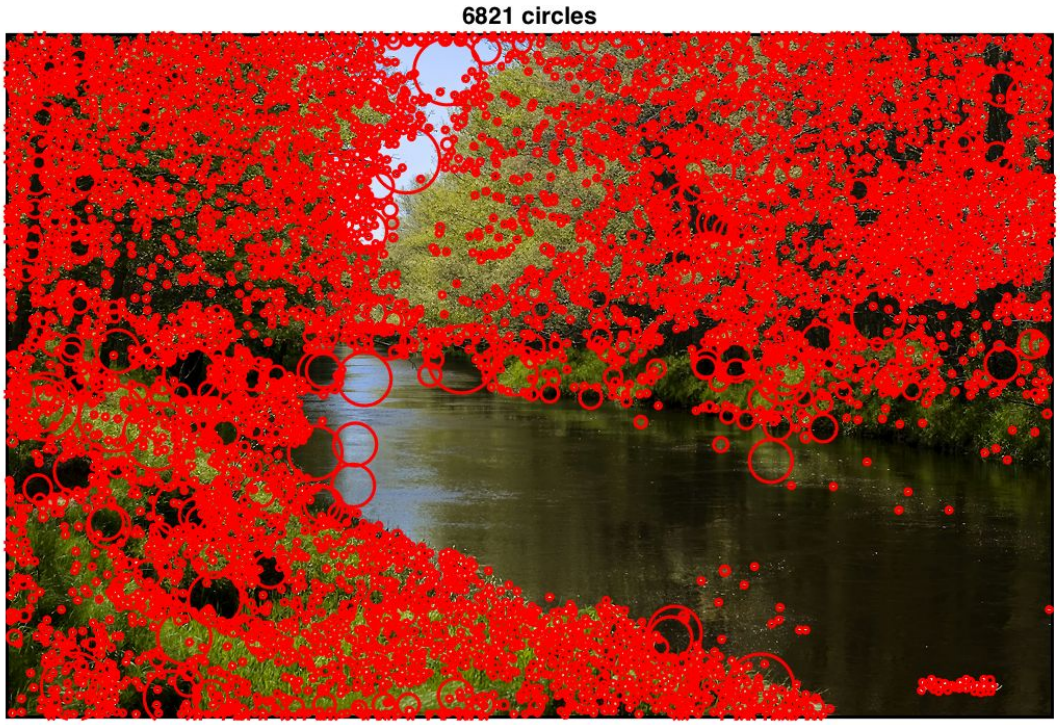


611 circles

For pikachu.jpg with mode FIL, it takes:
Elapsed time is 2.669492 seconds.

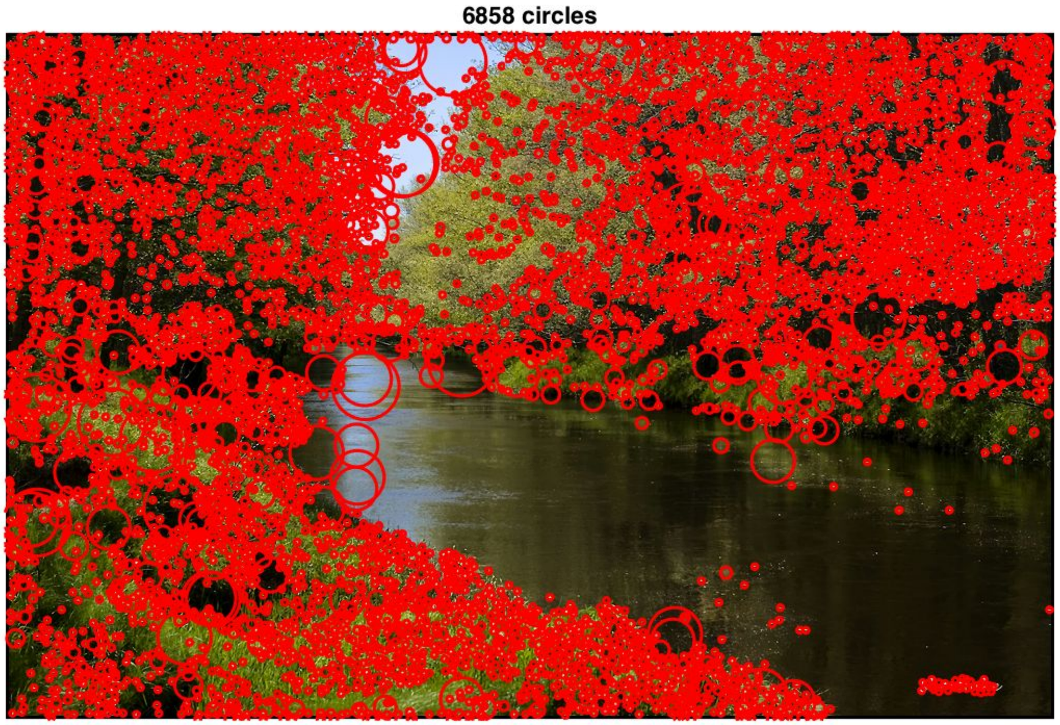


For river.jpg with mode SP, it takes:
Elapsed time is 2.186630 seconds.

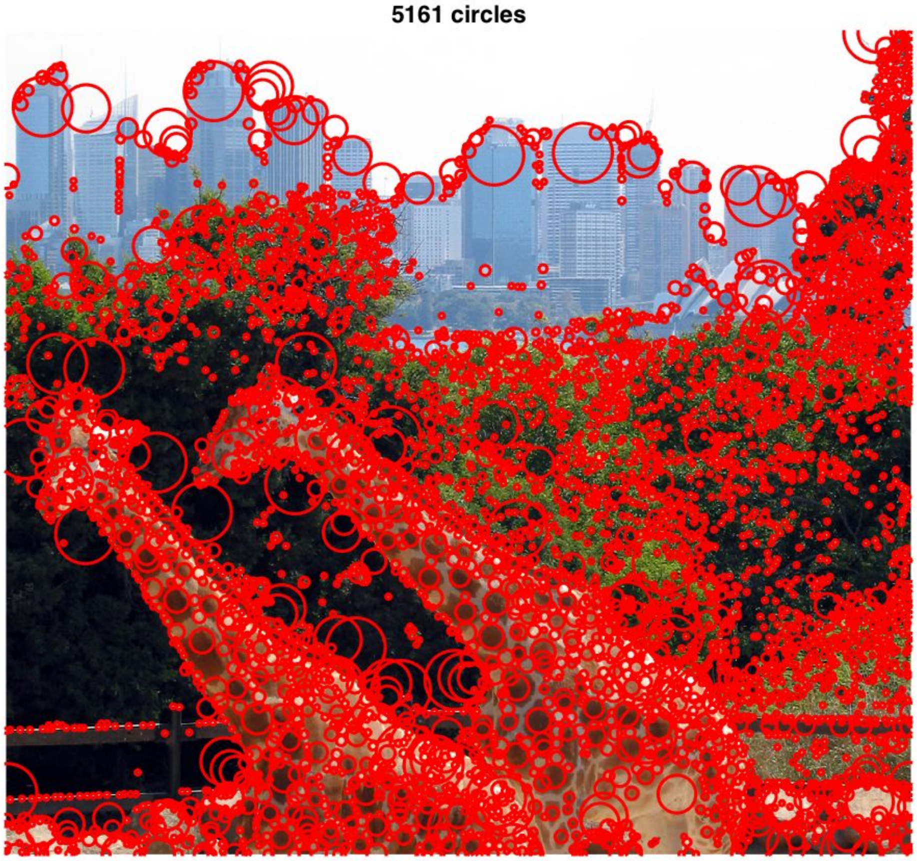


6821 circles

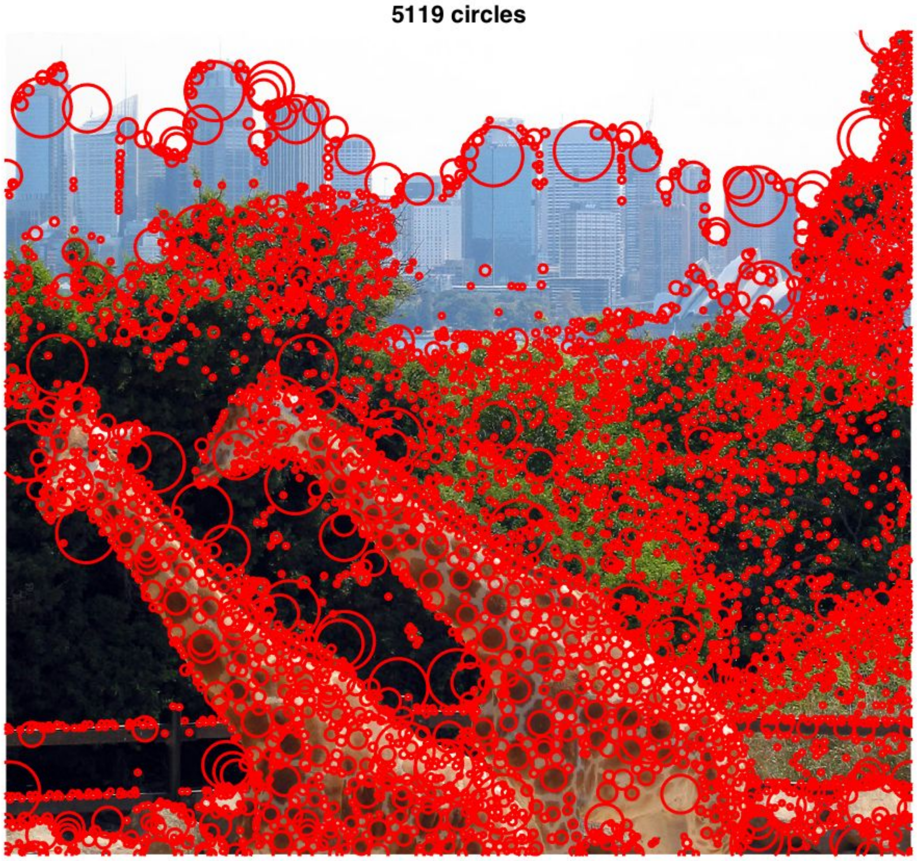
For river.jpg with mode FIL, it takes:
Elapsed time is 7.398964 seconds.



For zoo.jpg with mode SP, it takes:
Elapsed time is 2.809390 seconds.

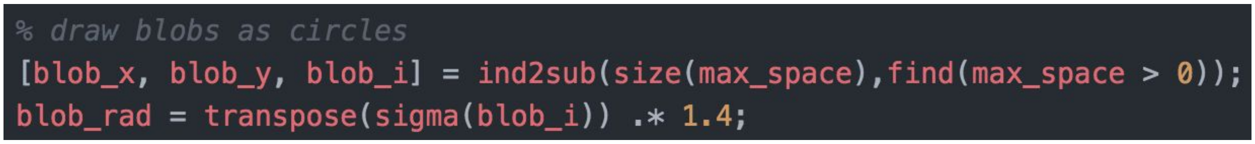


For zoo.jpg with mode FIL, it takes:
Elapsed time is 8.746622 seconds.



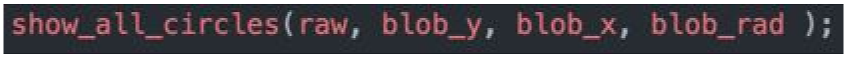
2. An explanation of any "interesting" implementation choices that you made.

- I use ind2sub with find makes code more concise.

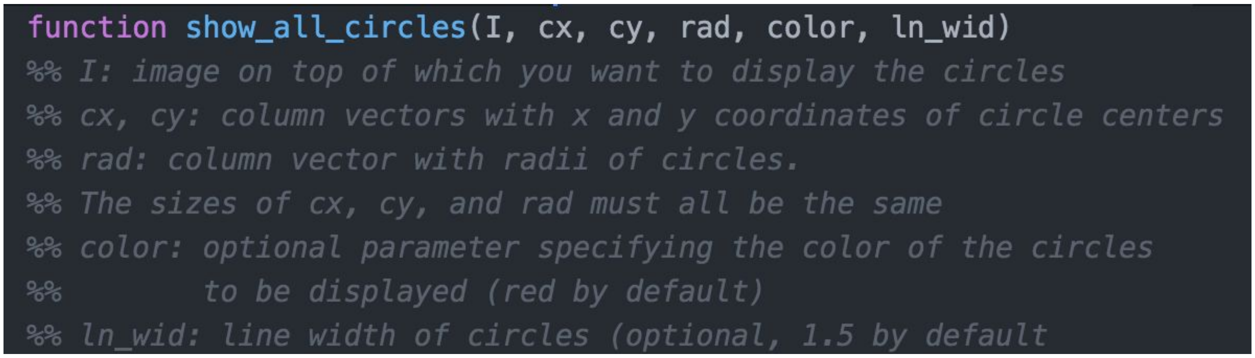


```
% draw blobs as circles
[blob_x, blob_y, blob_i] = ind2sub(size(max_space),find(max_space > 0));
blob_rad = transpose(sigma(blob_i)) .* 1.4;
```

- I think the arguments cx and cy of show_all_circles are confusing.
  They are not consistent with the x- and y-coordinates of the loaded images.



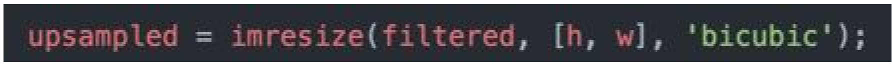
```
show_all_circles(raw, blob_y, blob_x, blob_rad );
```



```
function show_all_circles(I, cx, cy, rad, color, ln_wid)
%% I: image on top of which you want to display the circles
%% cx, cy: column vectors with x and y coordinates of circle centers
%% rad: column vector with radii of circles.
%% The sizes of cx, cy, and rad must all be the same
%% color: optional parameter specifying the color of the circles
%%         to be displayed (red by default)
%% ln_wid: line width of circles (optional, 1.5 by default
```

- Using ordfilt2 is faster than using colfilt while nlfilter is painfully slow.

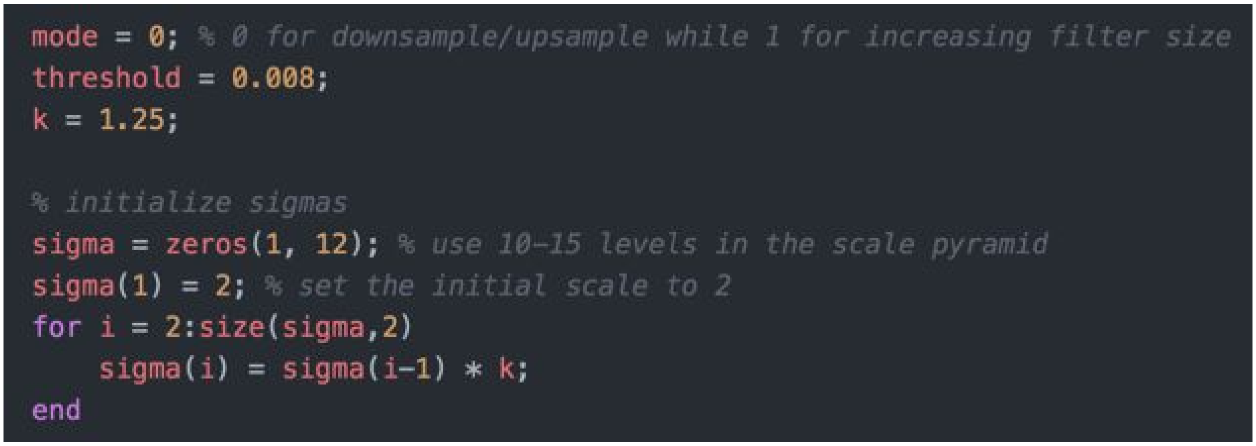
- Upsampling with ‘bilinear’ is lossy. So I use ‘bicubic’.



```
upsampled = imresize(filtered, [h, w], 'bicubic');
```

3. An explanation of parameter values you have tried and which ones you found to be optimal.

- I chose parameter values with the attempt to make the outputs as similar as the sample outputs as possible. That way, it's easier to check if the intermediate results are same as the ones on the lecture slides.



```
mode = 0; % 0 for downsample/upsample while 1 for increasing filter size
threshold = 0.008;
k = 1.25;

% initialize sigmas
sigma = zeros(1, 12); % use 10-15 levels in the scale pyramid
sigma(1) = 2; % set the initial scale to 2
for i = 2:size(sigma,2)
    sigma(i) = sigma(i-1) * k;
end
```

- The level of scale pyramid largely decides how much time it takes. With k=15, it's a bit slow. So I set it as 12.

- For debugging, it helps to set k larger and the level of scale pyramid smaller.

4. Discussion and results of any extensions or bonus features you have implemented.

I have not implemented anything extra.