```
  funx0 = largest_eigenval_s7_input(x0)
  funb = largest_eigenval_s7_input(b)
  if abs(funx0-1) < tolerance
    break
  elseif sign(funx0-1) == sign(funb-1)
    b = x0;
  else
    a = x0;
  end
  k
end

out = x0;

end
```

Problem 2

(a)

This is my favorite picture :)

```
training_data = readmatrix('training_cats.csv');
[m,n] = size(training_data);
h = 200;
w = 200;

for i = 1:129
    img = reshape(training_data(i,:), [h,w]);
    figure()
    imshow(img,[])
end
```

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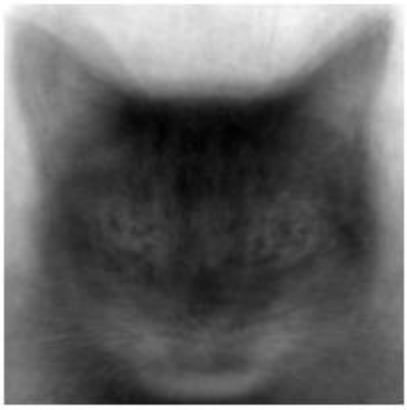
(b)



```
avg_img = mean(training_data);
imshow(reshape(avg_img,[h,w]),[])
```

(c)

```
X = training_data - ones(m,1) * avg_img;
% img = reshape(training_data(34,:), [h,w]);
% imshow(img,[])
[U,S,V] = svd(X,'econ');
scores = U*S;
```

(d)

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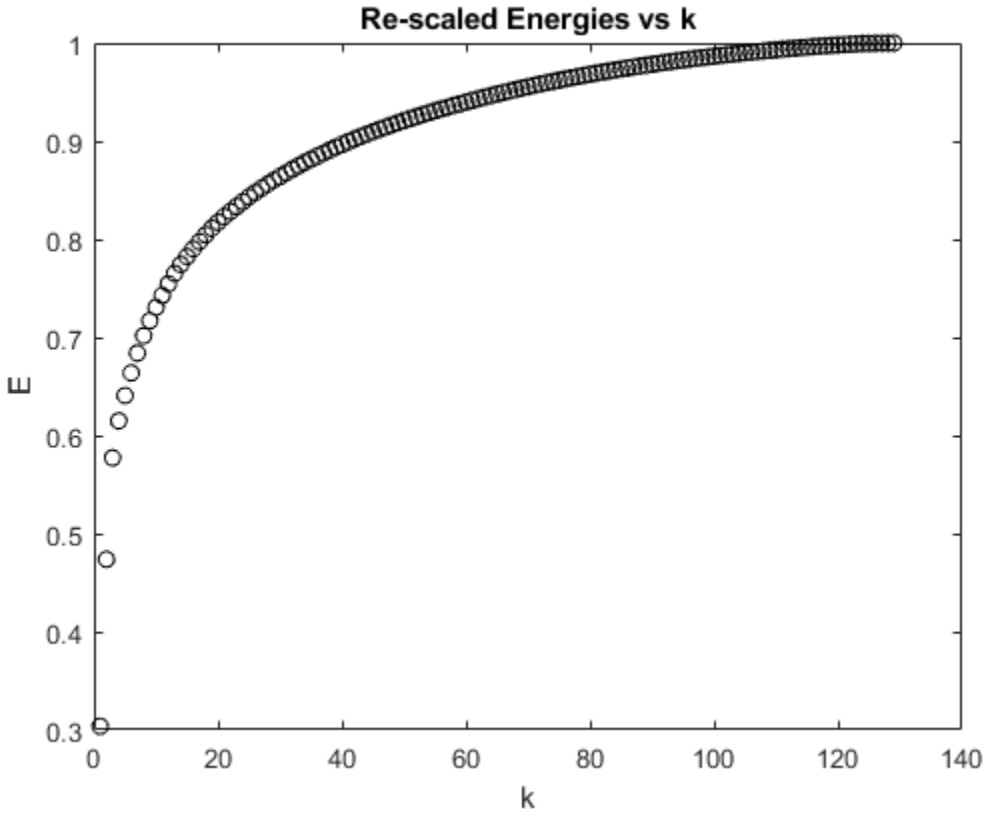

The smallest number of singular values that capture more than 99% of the information in this data set is 105.

```
s = diag(S);
E = cumsum(s.^2)/sum(s.^2);
plot(E,'ko')
xlabel('k')
ylabel('E')
title('Re-scaled Energies vs k')

for j = 1:129
    if E(j)>0.99
        break
    end
end
j
```

(e)

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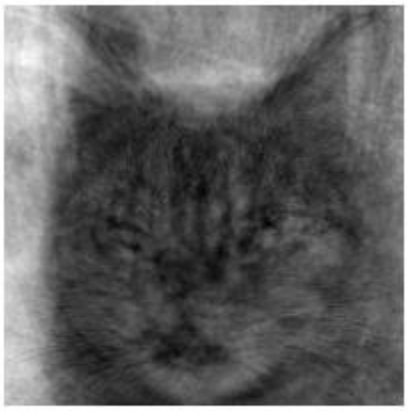
```
figure()
for k = 1:3
    img = reshape(V(:,k),[h,w]);
    subplot(1,3,k)
    imshow(img,[])
end
```

(f)



```
N = 40;
Un = U(:,1:N);
Vn = V(:,1:N);
Sn = diag(s(1:N));
reconstructed_data = Un * Sn * Vn';
img = reconstructed_data(34,:)+avg_img;
imshow(reshape(img,[h,w]),[])
```

(g)

The indices of the five closest images are 78, 107, 128, 113, and 74. Four of these images are of Nandor, and one was of Boris. I am very confident that the image cat1 is a picture of Nandor, although I would not say I am 100% sure.

```
testing_data = readmatrix('testing_cats.csv');
cat1 = testing_data(1,:);

score1 = (cat1 - avg_img)*V;
distances1 = zeros(1,129);
for k = 1:129
    distances1(k) = norm(score1 - scores(k,:));
end
[~, indices1] = sort(distances1);

img = reshape(training_data(78,:), [h,w]);
imshow(img,[])

figure()
img = reshape(training_data(107,:), [h,w]);
imshow(img,[])

figure()
img = reshape(training_data(128,:), [h,w]);
```

```
imshow(img,[])

figure()
img = reshape(training_data(113,:), [h,w]);
imshow(img,[])

figure()
img = reshape(training_data(74,:), [h,w]);
imshow(img,[])
```

(h)

The indices of the five closest images are 70, 37, 20, 14, and 33. All five of these images are of Boris. I am very confident that the image cat2 is a picture of Boris.

```
cat2 = testing_data(2,:);
score2 = (cat2 - avg_img)*V;
distances2 = zeros(1,129);
for k = 1:129
    distances2(k) = norm(score2 - scores(k,:));
end
[~, indices2] = sort(distances2);

img = reshape(training_data(70,:), [h,w]);
imshow(img,[])

figure()
img = reshape(training_data(37,:), [h,w]);
imshow(img,[])

figure()
img = reshape(training_data(20,:), [h,w]);
imshow(img,[])

figure()
img = reshape(training_data(14,:), [h,w]);
imshow(img,[])

figure()
img = reshape(training_data(33,:), [h,w]);
imshow(img,[])
```