

```
load('building256.mat')
X = building256/255;
```

```
% a
C = X*X'
```

```
C = 256x256
242.8823 242.6921 242.5849 242.2224 242.3723 242.4943 242.3410 242.6505 ...
242.6921 242.5772 242.4313 242.0689 242.2204 242.3420 242.1862 242.4918
242.5849 242.4313 242.3654 241.9604 242.1112 242.2369 242.0824 242.3853
242.2224 242.0689 241.9604 241.6424 241.7473 241.8747 241.7177 242.0258
242.3723 242.2204 242.1112 241.7473 241.9348 242.0253 241.8715 242.1717
242.4943 242.3420 242.2369 241.8747 242.0253 242.1966 241.9904 242.2975
242.3410 242.1862 242.0824 241.7177 241.8715 241.9904 241.8777 242.1454
242.6505 242.4918 242.3853 242.0258 242.1717 242.2975 242.1454 242.4840
242.0516 241.8996 241.7886 241.4254 241.5780 241.7005 241.5482 241.8506
241.9173 241.7598 241.6530 241.2898 241.4390 241.5684 241.4087 241.7192
:
:
```

```
% b
[V, D] = eigs(C);
[d, ind] = sort(diag(D), 'descend');
Ds = D(ind, ind);
Vs = V(:, ind);
```

```
sigma = diag(Ds);
sigma = sigma(1:5)
```

```
sigma = 5x1
104 ×
3.8236
0.0679
0.0247
0.0070
0.0035
```

```
u = Vs(:, 1:5)
```

```
u = 256x5
0.0796 0.0217 -0.0096 0.0394 -0.0825
0.0795 0.0207 -0.0094 0.0380 -0.0781
0.0795 0.0211 -0.0077 0.0380 -0.0782
0.0794 0.0212 -0.0076 0.0360 -0.0738
0.0794 0.0218 -0.0068 0.0371 -0.0734
0.0795 0.0228 -0.0081 0.0382 -0.0746
0.0794 0.0215 -0.0083 0.0404 -0.0775
0.0795 0.0216 -0.0089 0.0362 -0.0775
0.0793 0.0212 -0.0083 0.0373 -0.0782
0.0793 0.0214 -0.0085 0.0379 -0.0755
:
:
```

```
% c
V = zeros(size(u));
for i = 1:length(sigma)
```

```

V(:,i)= sigma(i)^(-1/2)*X'*u(:,i);
end

% Each column in V represents vi where i is the column index
V

```

```

V = 256x5
    0.0607    -0.0760    -0.0344    -0.0090    -0.0956
    0.0618    -0.0802    -0.0367    -0.0047    -0.0819
    0.0615    -0.0751    -0.0409     0.0058    -0.0749
    0.0611    -0.0688    -0.0475     0.0245    -0.0459
    0.0606    -0.0650    -0.0467     0.0430    -0.0407
    0.0606    -0.0640    -0.0511     0.0456    -0.0379
    0.0605    -0.0586    -0.0497     0.0456    -0.0499
    0.0603    -0.0583    -0.0519     0.0478    -0.0407
    0.0605    -0.0576    -0.0522     0.0526    -0.0506
    0.0604    -0.0581    -0.0493     0.0539    -0.0463
    :
    :

```

```

% d
X_i1 = sigma(1)^(1/2)*u(:,1)*V(:,1)';
X_i2 = sigma(2)^(1/2)*u(:,2)*V(:,2)';
X_i3 = sigma(3)^(1/2)*u(:,3)*V(:,3)';
X_i4 = sigma(4)^(1/2)*u(:,4)*V(:,4)';
X_i5 = sigma(5)^(1/2)*u(:,5)*V(:,5)';

X_k1 = X_i1

```

```

X_k1 = 256x256
    0.9441    0.9619    0.9569    0.9504    0.9428    0.9431    0.9418    0.9381 ...
    0.9436    0.9614    0.9565    0.9499    0.9424    0.9426    0.9413    0.9377
    0.9432    0.9610    0.9560    0.9495    0.9419    0.9422    0.9409    0.9372
    0.9419    0.9596    0.9547    0.9482    0.9406    0.9408    0.9396    0.9359
    0.9424    0.9602    0.9552    0.9487    0.9411    0.9414    0.9401    0.9364
    0.9428    0.9606    0.9557    0.9491    0.9416    0.9418    0.9406    0.9369
    0.9422    0.9599    0.9550    0.9485    0.9409    0.9412    0.9399    0.9362
    0.9434    0.9612    0.9563    0.9497    0.9421    0.9424    0.9411    0.9375
    0.9411    0.9588    0.9539    0.9474    0.9399    0.9401    0.9389    0.9352
    0.9406    0.9583    0.9534    0.9469    0.9393    0.9396    0.9383    0.9347
    :
    :

```

```

X_k2 = X_i1+X_i2

```

```

X_k2 = 256x256
    0.9011    0.9165    0.9144    0.9115    0.9060    0.9068    0.9087    0.9051 ...
    0.9026    0.9180    0.9159    0.9128    0.9072    0.9080    0.9097    0.9062
    0.9014    0.9168    0.9147    0.9116    0.9062    0.9070    0.9087    0.9052
    0.8999    0.9153    0.9132    0.9102    0.9047    0.9055    0.9073    0.9037
    0.8992    0.9145    0.9125    0.9096    0.9041    0.9050    0.9068    0.9033
    0.8977    0.9129    0.9110    0.9082    0.9029    0.9038    0.9058    0.9022
    0.8996    0.9150    0.9129    0.9099    0.9045    0.9053    0.9071    0.9036
    0.9006    0.9160    0.9139    0.9110    0.9055    0.9063    0.9081    0.9046
    0.8992    0.9146    0.9125    0.9095    0.9040    0.9048    0.9065    0.9030
    0.8983    0.9136    0.9115    0.9085    0.9031    0.9039    0.9057    0.9022
    :
    :

```

```
X_k3 = X_i1+X_i2+X_i3
```

```
X_k3 = 256x256
```

0.9063	0.9220	0.9206	0.9186	0.9131	0.9146	0.9162	0.9130 ...
0.9076	0.9235	0.9219	0.9198	0.9141	0.9156	0.9170	0.9138
0.9056	0.9213	0.9197	0.9174	0.9118	0.9132	0.9147	0.9115
0.9040	0.9197	0.9181	0.9159	0.9103	0.9116	0.9132	0.9100
0.9028	0.9184	0.9168	0.9146	0.9091	0.9104	0.9121	0.9088
0.9020	0.9176	0.9162	0.9143	0.9089	0.9103	0.9121	0.9088
0.9041	0.9197	0.9182	0.9161	0.9106	0.9120	0.9136	0.9103
0.9054	0.9211	0.9196	0.9176	0.9120	0.9134	0.9151	0.9118
0.9037	0.9193	0.9178	0.9156	0.9100	0.9114	0.9130	0.9098
0.9029	0.9185	0.9170	0.9149	0.9094	0.9108	0.9124	0.9092
⋮							

```
X_k4 = X_i1+X_i2+X_i3+X_i4
```

```
X_k4 = 256x256
```

0.9033	0.9205	0.9225	0.9267	0.9273	0.9296	0.9312	0.9287 ...
0.9048	0.9220	0.9237	0.9275	0.9278	0.9301	0.9315	0.9290
0.9027	0.9198	0.9215	0.9252	0.9255	0.9276	0.9292	0.9266
0.9013	0.9183	0.9198	0.9232	0.9232	0.9254	0.9269	0.9243
0.9000	0.9169	0.9186	0.9222	0.9224	0.9245	0.9262	0.9236
0.8992	0.9161	0.9181	0.9221	0.9226	0.9248	0.9266	0.9241
0.9011	0.9182	0.9202	0.9244	0.9251	0.9273	0.9290	0.9265
0.9027	0.9197	0.9214	0.9250	0.9250	0.9272	0.9288	0.9263
0.9009	0.9179	0.9196	0.9232	0.9234	0.9256	0.9272	0.9247
0.9000	0.9170	0.9189	0.9227	0.9230	0.9252	0.9268	0.9243
⋮							

```
X_k5 = X_i1+X_i2+X_i3+X_i4+X
```

```
X_k5 = 256x256
```

1.8759	1.9087	1.9107	1.8993	1.9155	1.9178	1.9038	1.9013 ...
1.8773	1.9102	1.8963	1.9001	1.9003	1.9026	1.9198	1.9016
1.8753	1.8923	1.9097	1.8977	1.8980	1.9159	1.9174	1.8992
1.8739	1.9065	1.8924	1.9115	1.8958	1.8979	1.8995	1.9126
1.8412	1.8895	1.9069	1.8947	1.8950	1.8971	1.8988	1.8962
1.8403	1.8886	1.8906	1.8946	1.8638	1.8974	1.8992	1.8966
1.8736	1.9064	1.8927	1.8969	1.8976	1.9156	1.9015	1.8990
1.8752	1.8922	1.9096	1.8975	1.8976	1.9155	1.9014	1.8675
1.8420	1.9061	1.8608	1.8644	1.8960	1.8982	1.8684	1.8658
1.8412	1.8896	1.9071	1.8952	1.8642	1.8664	1.8994	1.8655
⋮							

```
% e
fro_X = norm(X, 'fro');

e_1 = norm((X_k1-X), 'fro')/fro_X

e_1 = 0.1742

e_2 = norm((X_k2-X), 'fro')/fro_X

e_2 = 0.1145
```

```
e_3 = norm((X_k3-X), 'fro')/fro_X
```

```
e_3 = 0.0828
```

```
e_4 = norm((X_k4-X), 'fro')/fro_X
```

```
e_4 = 0.0713
```

```
e_5 = norm((X_k5-X), 'fro')/fro_X
```

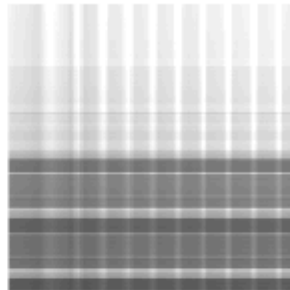
```
e_5 = 0.9975
```

```
% f
figure(1)
subplot(221)
imshow(X)
title("original building256")
subplot(222)
imshow(X_k1)
title("rank-1 approximation")
subplot(223)
imshow(X_k3)
title("rank-3 approximation")
subplot(224)
imshow(X_k5)
title("rank-5 approximation")
```

original building256



rank-1 approximation



rank-3 approximation



rank-5 approximation



```
% g
V_values = prod(size(V));
sigma_values = prod(size(sigma));
u_values = prod(size(u));

n5 = V_values + sigma_values + u_values;
compression_ratio = (256^2)/n5

compression_ratio = 25.5501
```