


4.2.19

```
k=10
for i=1:k
    svd(randn(5,4))
end
```





4.2.20

```
A=randn(8,4);
A(:,5:6)=A(:,1:2)+A(:,3:4);
[Q,R]=qr(randn(6));
A=A*Q
```

a)no

b)

```
format short e;
svd(A)
```




c)

```
rank(A)
```



d)

```
rank(A,10^-17)
```



4.2.21

a)largest main diagonal entry is a11 and smallest is ann=s^(n-1)

```
sin(1.2)^89
```

b)

```
A=gallery('kahan',90,1.2,0)
format short e
sig=svd(A)

rank(A)
```

c)

```
A=gallery('kahan',90,1.2,25)
format short e
```

```

sig=svd(A)

rank(A)

[Q,R,E]=qr(A);
dif=norm(eye(90)-E)
R
R(90,90)

```

The theoretical rank of A is 90

Its numerical rank by taking tolerance as $\epsilon \cdot \|\sigma\|_1$ is 89 which is shown by the rank command

But when we do rank revealing QR decomposition, it showed rank to be 90

```

load clown.mat;
X

```

```

X = 200x320
      2      2      2      2      2      2      2      2      2      2      2      2      2 ...
61      69      69      69      69      69      69      69      69      69      69      69      69
69      61      69      61      69      59      69      59      69      69      69      59      69
61      69      61      61      56      61      61      61      61      69      61      69      61
69      55      61      44      61      59      69      61      69      63      69      61      69
61      61      61      61      61      69      61      69      61      69      61      69      63
69      55      61      55      69      55      69      61      69      59      69      43      61
55      56      55      56      56      63      61      61      61      61      55      56      55
56      38      56      55      69      55      61      55      61      59      61      44      61
55      56      55      61      56      61      61      61      55      56      55      61      56
      ⋮

```

```

[U, S, V] = svd(X)

```

```

U = 200x200
-4.1774e-03 -2.4165e-03 -3.2882e-03 -1.8505e-03 1.1921e-03 -2.1356e-03 ...
-1.0573e-01 -1.5373e-01 -4.2668e-02 1.2353e-02 -7.2497e-02 -3.4482e-02
-1.0030e-01 -1.5044e-01 -3.4072e-02 2.3867e-02 -5.5874e-02 -1.9922e-02
-9.6495e-02 -1.5844e-01 -3.2879e-02 4.7623e-02 -2.0566e-02 -2.0778e-02
-9.8927e-02 -1.4210e-01 -1.8346e-02 4.1466e-02 -4.9050e-02 -7.5325e-03
-1.0449e-01 -1.1307e-01 -6.5345e-03 6.9777e-02 -2.3420e-02 2.5840e-02
-1.0965e-01 -6.6653e-02 -1.2823e-02 9.4958e-02 4.3620e-02 2.6862e-03
-1.0507e-01 -5.7563e-02 -5.9747e-03 1.1231e-01 3.0253e-02 5.2693e-03
-1.0898e-01 -5.0719e-02 -1.4259e-02 1.0764e-01 3.6597e-02 -3.6183e-02
-1.0928e-01 -3.8250e-02 -2.6152e-02 1.2555e-01 4.7083e-02 -4.1274e-02
      ⋮

S = 200x320
8.1571e+03      0      0      0      0      0 ...
      0 2.0618e+03      0      0      0      0
      0      0 1.7765e+03      0      0      0
      0      0      0 1.2676e+03      0      0
      0      0      0      0 1.1218e+03      0
      0      0      0      0      0 1.0699e+03
      0      0      0      0      0      0
      0      0      0      0      0      0
      0      0      0      0      0      0
      0      0      0      0      0      0

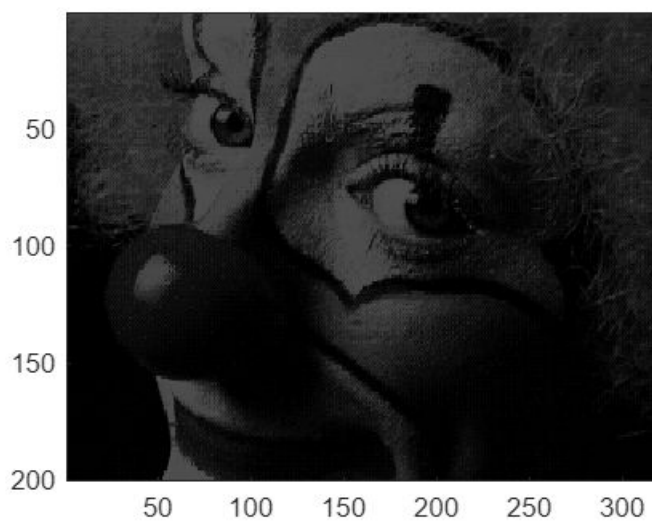
```

```

      ⋮
V = 320×320
-3.2542e-02 -3.7265e-02 -4.4804e-02 4.6589e-02 1.5367e-02 1.9624e-02 ...
-3.0609e-02 -4.0963e-02 -5.4726e-02 4.9856e-02 1.2009e-02 1.9661e-02
-3.4467e-02 -3.9505e-02 -6.0124e-02 4.3487e-02 1.4398e-02 2.8945e-02
-3.2511e-02 -3.6022e-02 -5.8809e-02 3.3960e-02 1.9534e-02 3.6463e-02
-3.7811e-02 -4.2222e-02 -5.9607e-02 2.0618e-02 1.1573e-02 3.8728e-02
-3.7068e-02 -4.6768e-02 -5.4559e-02 2.5671e-02 1.9972e-04 3.1583e-02
-4.2571e-02 -5.2797e-02 -5.1563e-02 3.0550e-02 2.0739e-03 3.2387e-02
-3.9333e-02 -5.3753e-02 -5.4304e-02 2.2068e-02 5.9252e-03 3.1581e-02
-4.4710e-02 -6.0303e-02 -5.8535e-02 1.4197e-02 4.1213e-03 2.6613e-02
-4.1590e-02 -5.8815e-02 -5.0092e-02 1.1553e-02 -7.2566e-03 3.7124e-02
      ⋮

```

```
colormap('gray')
```



```

relerr=[];
compratio=[];
sig=svd(X)

```

```

sig = 200×1
8.1571e+03
2.0618e+03
1.7765e+03
1.2676e+03
1.1218e+03
1.0699e+03
8.9870e+02
7.1227e+02
6.8332e+02
6.5267e+02
      ⋮

```

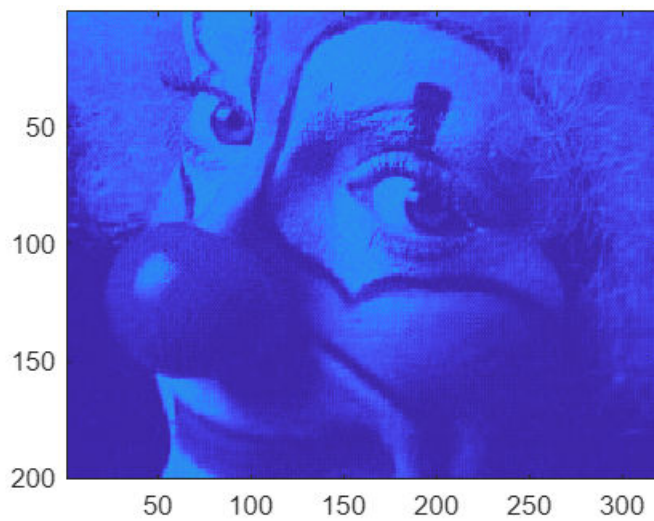
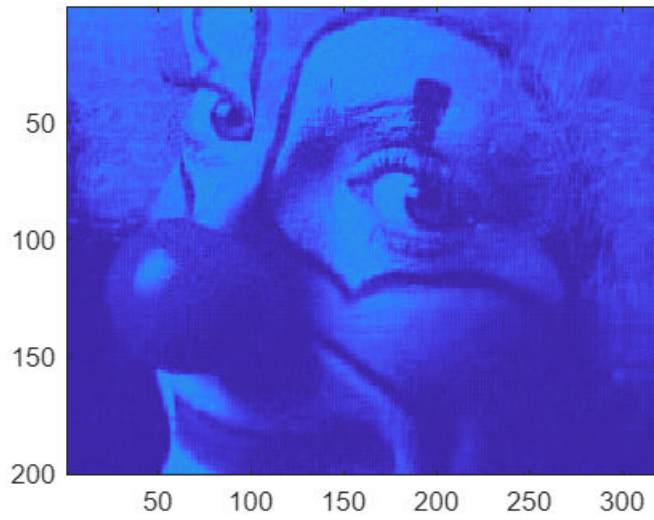
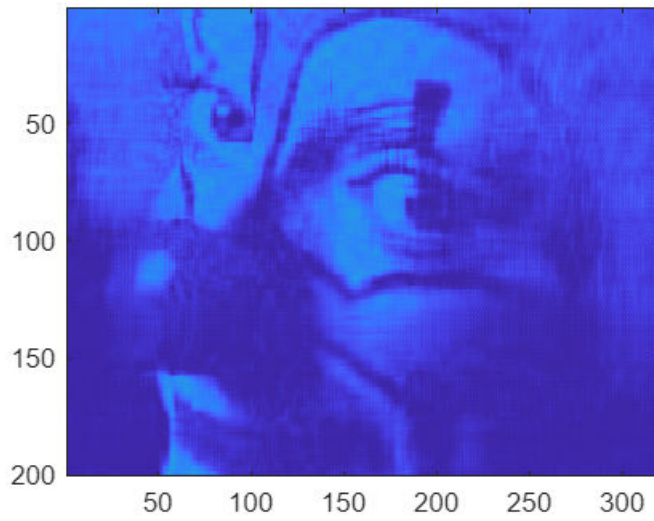
```

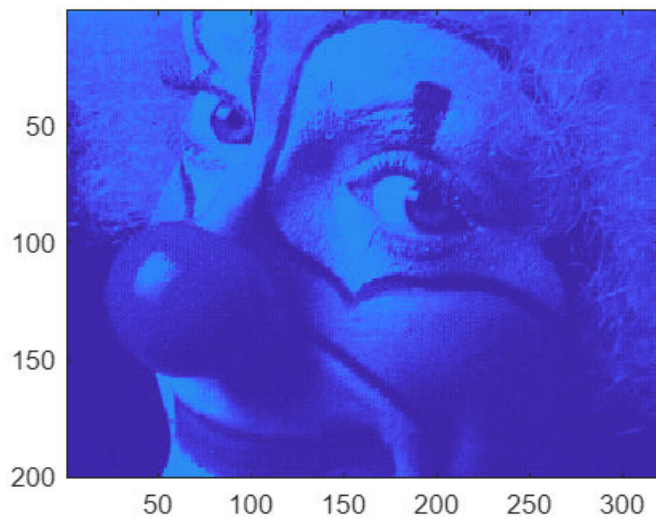
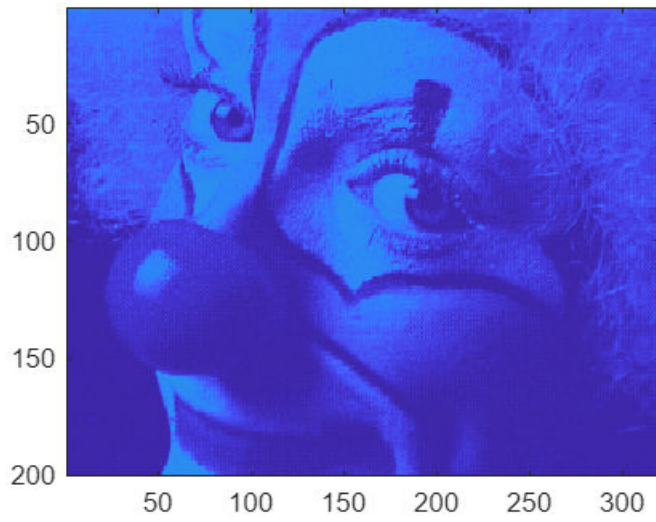
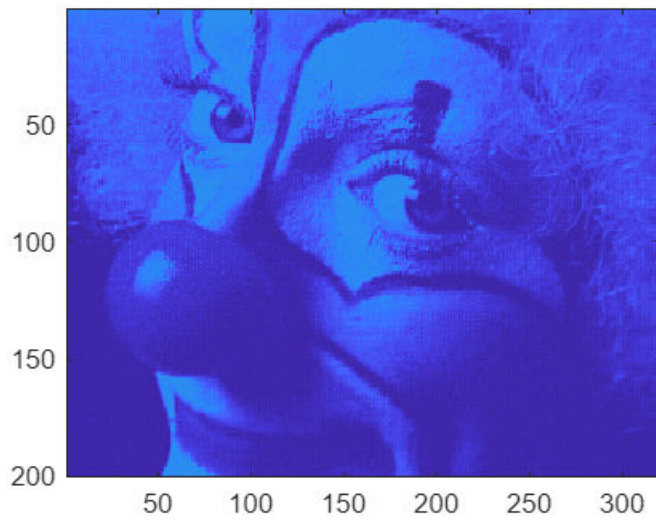
for k=[20:20:200]
    figure;
    image(U(:, 1:k)*S(1:k, 1:k)*V(:,1:k)')
    relerr(end+1)=sig(k)/sig(1);

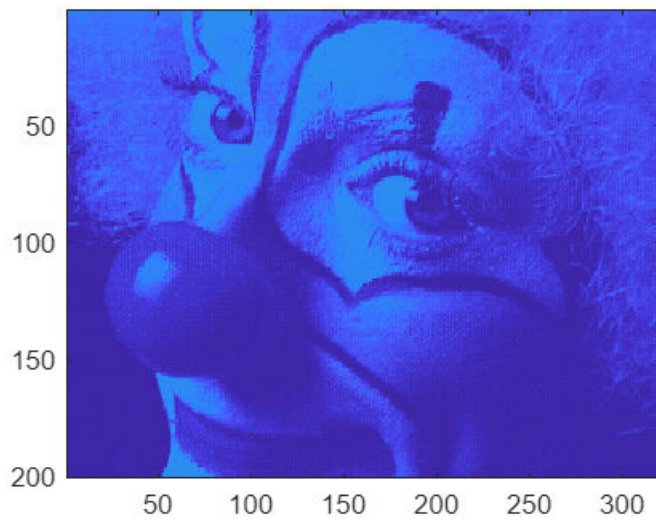
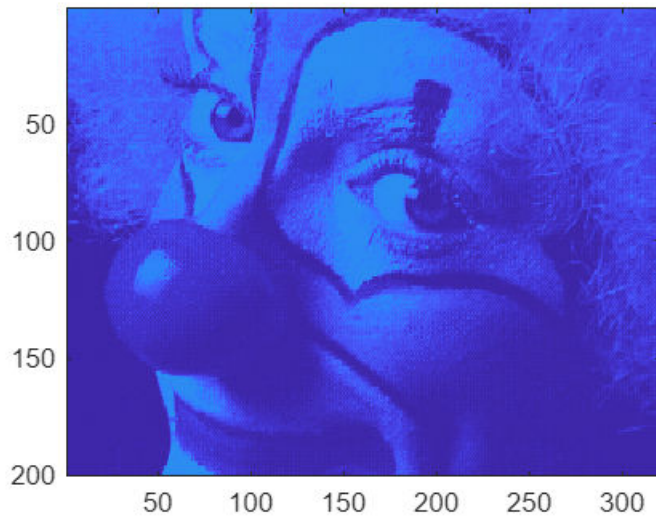
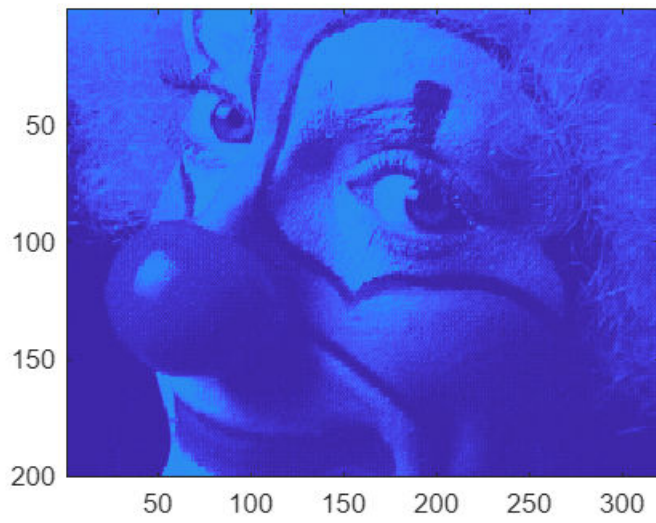
```

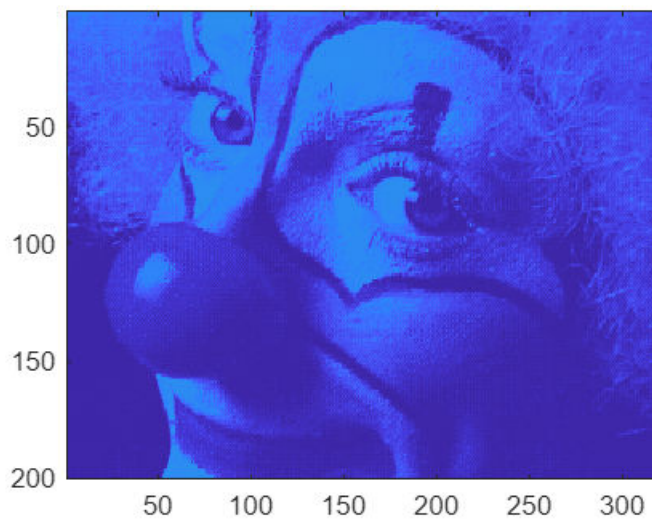
$\text{sig}(k+1)$

```
compratio(end+1)=520*k/6400;  
end
```









```
table([20:20:200].',relerr.',compratio.','VariableNames',{'k','relative errors','compression ratio'})
```

```
ans = 10×3 table
```

	k	relative errors	compression ratio
1	20	4.3269e-02	1.6250e+00
2	40	2.2500e-02	3.2500e+00
3	60	1.6840e-02	4.8750e+00
4	80	1.3369e-02	6.5000e+00
5	100	1.0585e-02	8.1250e+00
6	120	8.4336e-03	9.7500e+00
7	140	6.4951e-03	1.1375e+01
8	160	4.7517e-03	13
9	180	3.1465e-03	1.4625e+01
10	200	2.9503e-04	1.6250e+01