PCA

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a

$M^T M$:

```
[[36 37 38]
 [37 49 61]
 [38 61 84]]
```

MM^T:

```
[[14 26 22 16 22]
 [26 50 46 28 40]
 [22 46 50 20 32]
 [16 28 20 20 26]
 [22 40 32 26 35]]
```

b

$M^T M$:

```
[1.53566996e+02, 1.54330035e+01, 4.80589926e-15]
```

MM^T:

```
[ 1.53566996e+02, -1.03322028e-14,  1.54330035e+01,  2.54653026e-15, -3.61063094e-15]
```

c

$M^T M$:

```
[[-0.40928285, -0.81597848,  0.40824829],
 [-0.56345932, -0.12588456, -0.81649658],
 [-0.7176358 ,  0.56420935,  0.40824829]]
```

MM^T:

```
[[ 0.29769568,  0.94131607, -0.15906393,  0.12508859,  0.07520849],
 [ 0.57050856, -0.17481584,  0.0332003 , -0.45318832, -0.07287035],
 [ 0.52074297, -0.04034212,  0.73585663,  0.32553276, -0.10566284],
 [ 0.32257847, -0.18826321, -0.5103921 ,  0.72000366, -0.72571726],
 [ 0.45898491, -0.21515796, -0.41425998, -0.39318742,  0.67171677]]
```

d

$$U \sum V^T =$$

```
[[2.01999221 2.15753106 2.294701  ]
 [2.78722094 3.96738352 5.14683913]
 [0.28201452 3.27207577 6.26149176]
 [3.27243514 2.50516021 1.73748551]
 [3.65620978 3.41011117 3.16344375]]
```

e

$$M_1 = U_1 \sum{}_1 V_1^T =$$

```
[[1.5099, 2.0787, 2.6474],
 [2.8936, 3.9836, 5.0736],
 [2.6412, 3.6361, 4.6310],
 [1.6360, 2.2524, 2.8687],
 [2.3279, 3.2049, 4.0818]]
```

f

$$energy = \sigma_1^2 / || \sum ||^2 = 90.87\%$$