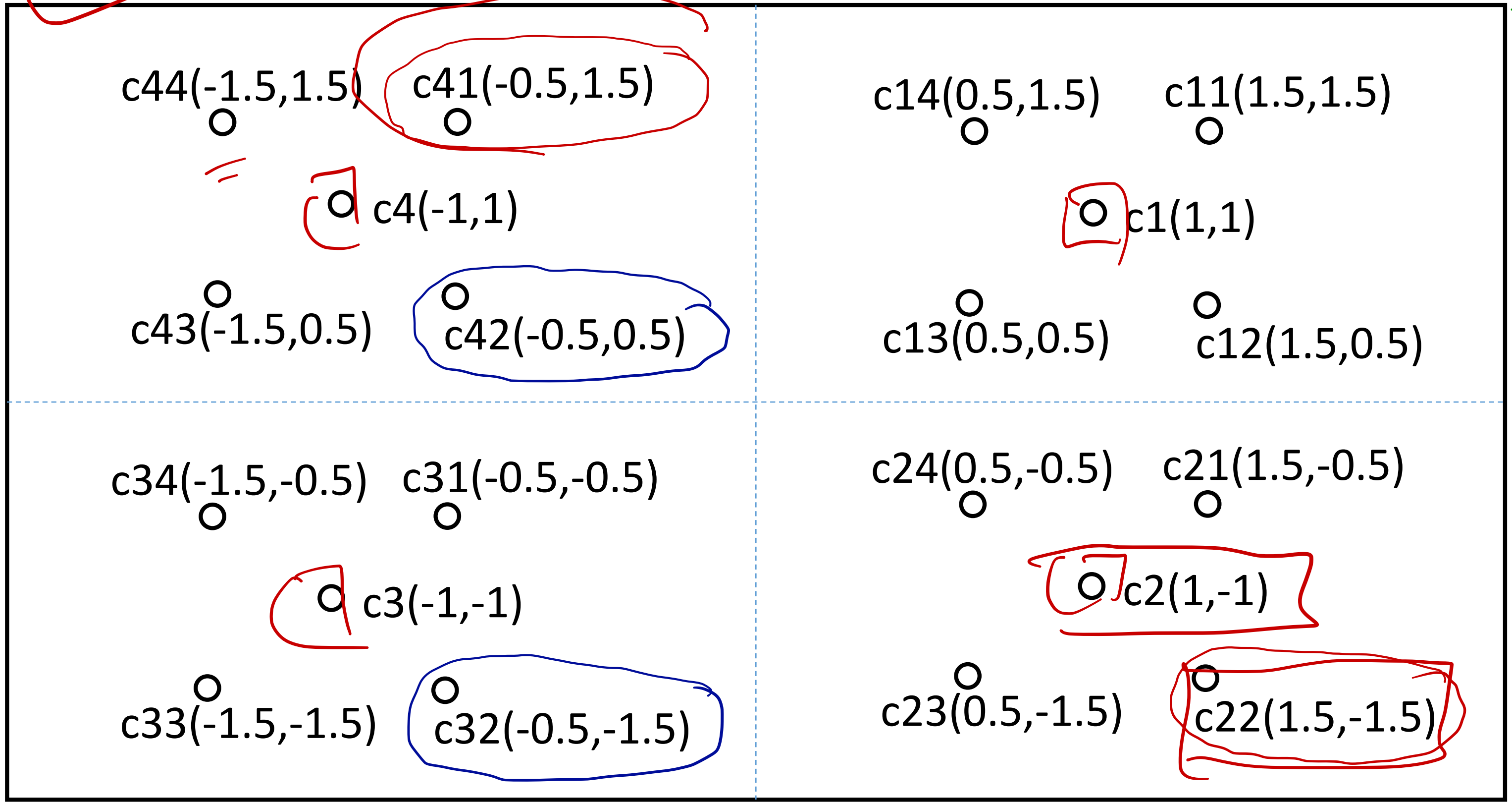
$I_1 = \{(-0.5,1.5), (1.5,-1.5)\}$

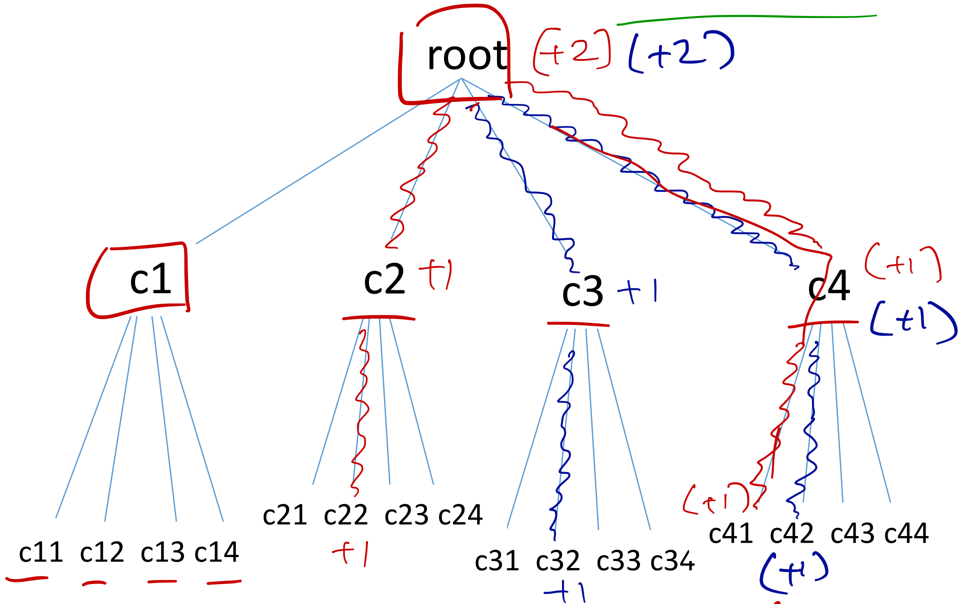
$I_2 = \{(-0.5,0.5), (-0.5,-1.5)\}$

2D

We are given two images I_1 and I_2. The images are represented using two 2D descriptors each.

Using the vocabulary tree find the normalized difference between I_1 and I_2





To find the normalized difference we represent each I_1 and I_2 using 21 dimensional vectors q_1 and q_2.

$q_1 = (2, 0,1, 0,1, 0,0,0,0,0,1,0,0,0,0,0,0,1,0,0,0)$

$q_2 = (2, 0,0,1,1, 0,0,0,0,0,0,0,0,0,1,0,0,0,1,0,0)$

$S(q_1,q_2) = |q_1 - q_2|_1 = 6$

We ignore the normalization factor assuming that each image has the same # of descriptors.

Vocabulary tree represents a hierarchical clustering of the descriptors. The cluster centers have the same dimension as the descriptors.

Given a descriptor how do you parse the tree.

Let $d_1 = (a, b)$ and $d_2 = (c, d)$

The similarity between d_1 and d_2 can be computed using the angle between the vectors

$$\cos\theta = \frac{d_1 \cdot d_2}{\sqrt{a^2+b^2}\,\sqrt{c^2+d^2}}$$

$$= \frac{ac + bd}{\sqrt{a^2+b^2}\,\sqrt{c^2+d^2}}$$

= varies from -1 to 1

If d_1 and d_2 are the same then they have the highest similarity

If you see the same vector as a cluster center then it has the maximum similarity.