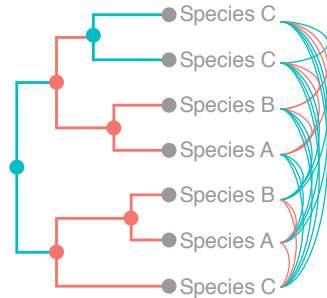


(a) Pairwise comparisons



This example tree has 21 nonindependent pairwise comparisons:

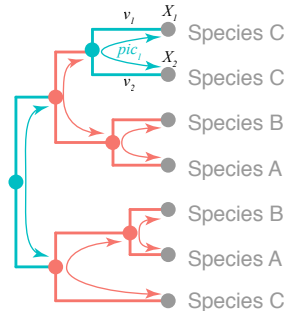
8 pairwise comparisons between **orthologs**

13 pairwise comparisons between **paralogs**

● Speciation event

● Duplication event

(b) Phylogenetic independent contrasts



The same example tree has 6 independent contrasts:

4 contrasts arising from speciation nodes

2 contrasts arising from duplication nodes

The value of the top contrast is:

$$pic_1 = \frac{X_1 - X_2}{v_1 + v_2}$$

Observed trait change (difference between descendant values)

Expected variance (total branch length)