Solution 1:

Note: This is only true assuming gaussian distributions. Otherwise, the ellipse of NB ends outside of that of QDA. But do not tell students this beforehand, they shall figure out by themselves that the question is kind of wrong – on purpose.

A is QDA, B and C are either LDA or Naive Bayes.

1) LDA can be seen as a special case of QDA if the covariance matrix is equal for all classes: $\Sigma_k = \Sigma \ \forall k$

2) Naive Bayes can be seen as a special case of QDA if the features are conditionally independent given class k:

$$p(\mathbf{x}|y=k) = p((x_1, x_2, ..., x_p)|y=k) = \prod_{j=1}^{p} p(x_j|y=k), \tag{1}$$

which results in diagonal covariance matrices.

3) Naive Bayes and LDA have an intersection if the covariance matrix is equal for all classes: $\Sigma_k = \Sigma \ \forall k$ **and** features are conditionally independent given class k, leaving each class with the same diagonal covariance matrix Σ.