Mandatory Exercise: NCA and RMQ

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1 The First Covering Ancestor Problem Let T be a rooted tree with n nodes. Each leaf in T is assigned a *label* from an alphabet Σ. Given a node $v \in T$, the *subtree rooted at* v is the tree consisting of v and all descendants of v. A node $v \in T$ *covers* a character $\alpha \in \Sigma$ if the subtree rooted at v contains a leaf labeled by α. We are interested in efficient data structures for T that support the following query. Let ℓ be a leaf in T and $\alpha \in \Sigma$.

- FCA(ℓ, α): return the deepest ancestor a of ℓ such that a covers α.

Give a linear-space data structure for T that supports fast FCA queries. You may assume that the root of T covers all characters in Σ.