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Q3 solution

Firstly we will begin by finding the heaviest apple among the 1024 apples. This will be achieved by the ‘divide and conquer’ method. At each iteration we will pick a random pair of apples to weigh disregarding the lighter one for the next iteration. However for the purpose of also finding the second heaviest apple we will need to keep track of which apple each one was weighed against. This is because it is possible along the way we might have compared the heaviest with the second heaviest. The number of apples weighed at each iteration respectively will be 512, 256, 128, 64, 32, 16, 8, 4, 2, 1 where weighing the last apple will result in us finding the heaviest apple. This will total to 1023 weighings.

To find the second heaviest now we will need to back track to all the apples we weighed against the heaviest apple which will be a total of $\log_2 1024 - 1$ = 9 comparisons. 1023 +9 = 1032 total comparisons.

A visual representation of the binary tree can also help identify the number of comparisons needed to find the second heaviest which if the below binary tree was extended it would be the number of black nodes. All other nodes below them are equal to or less than the ones in black.