Exercise 1: Concurrent Ivy

Consider the tree for the Ivy shared variable protocol in Figure 1. There are three concurrent requests placed by the nodes $v_1$, $v_2$, and $v_3$. The token is initially held by the circled node labeled $r$. We assume a synchronous execution.

1. Give the order of serviced requests.

2. Draw the tree after the last request has been served.

Exercise 2: Tight Ivy

In Theorem 4.5 in the lecture notes, it was shown that, on average, acquiring a lock requires at most $\log n$ steps, where $n$ is the number of processors. Show that this bound on the number of steps is tight by constructing a tree consisting of $n$ nodes in which each request requires $\log n$ steps if all requests are performed sequentially by suitable nodes in the tree.\(^1\)

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\(^1\)Hints: Assume that $n$ is a power of 2. Construct a tree whose topology remains the same with respect to the token holder after each request.