**Lemma 1.** *Fixer has a winning strategy against Breaker in the chronicled game on $P_5$ with superabundant list assignment $L$ where $|L(v_1)| = 2$, $|L(v_2)| = 3$, $|L(v_3)| = 2$, $|L(v_4)| = 3$ and $|L(v_5)| = 2$.*

*Proof.* We show that for each possible such list assignment $L$ on $G$, Fixer has a winning strategy. Up to symmetry, the following cases cover all the possible list assignments.

**Case 1.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,2,3\}$ *and* $L(v_5) = \{0,1\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph.

**Case 2.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,3\}$ *and* $L(v_5) = \{0,2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph.

**Case 3.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,3\}$ *and* $L(v_5) = \{0,2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 1 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 1 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 1 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph.

**Case 4.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,2\}$ *and* $L(v_5) = \{0,1\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 5.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 2\}$ *and* $L(v_5) = \{1, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph.

**Case 6.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 2\}$ *and* $L(v_5) = \{0, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 7.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 2\}$ *and* $L(v_5) = \{1, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_4$ and $v_1$. This results

in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph.

**Case 8.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{1,3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph.

**Case 9.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 10.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 11.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$

and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph.

**Case 12.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ *and* $L(v_5) = \{2, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_1$. This results in

a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph.

**Case 13.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,3\}$ *and* $L(v_5) = \{1,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 14.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 15.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 16.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 17.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 18.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 19.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in

a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 20.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 21.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph.

**Case 22.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph.

**Case 23.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 3\}$ *and* $L(v_5) = \{0, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 24.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 3\}$ *and* $L(v_5) = \{1, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 25.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 3\}$ *and* $L(v_5) = \{1, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results

in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 26.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 27.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 28.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and

$L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 29.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results

in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph.

**Case 30.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph.

**Case 31.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$

and $\{v_1, v_3\}$, then Fixer should swap 2 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph.

**Case 32.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 33.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 34.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 35.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph.

**Case 36.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 37.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 38.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results

in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 39.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 40.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 41.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and

$L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 42.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph.

**Case 43.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results

in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph.

**Case 44.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{3,4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 45.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 46.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 47.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 48.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in

a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph.

**Case 49.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex

sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 50.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 51.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 52.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph.

**Case 53.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 54.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 55.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph.

**Case 56.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists

$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 57.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ *and* $L(v_5) = \{3, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 58.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ *and* $L(v_5) = \{0, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 59.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 3\}$ *and* $L(v_5) = \{1, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 60.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ *and* $L(v_5) = \{1, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex

sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 61.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 62.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results

in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph.

**Case 63.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 64.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 65.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 66.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 67.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 68.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph.

**Case 69.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$ and $v_1$. This results

in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,4\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph.

**Case 70.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,4\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph.

**Case 71.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{1,2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,4\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph.

**Case 72.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{1,3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,4\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,4\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,4\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{1,4\}$, but then Fixer can edge-color the graph.

**Case 73.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{1,4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,4\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{1,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph.

**Case 74.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 75.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph.

**Case 76.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph.

**Case 77.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{4, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph.

**Case 78.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{4, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph.

**Case 79.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{4, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph.

**Case 80.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{4, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists

$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph.

**Case 81.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{4, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph.

**Case 82.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 5\}$, but then Fixer can edge-color the graph.

**Case 83.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph.

**Case 84.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{4, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$

and $\{v_1, v_4\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 5\}$, but then Fixer can edge-color the graph.

**Case 85.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 4, 5\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 86.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{0, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{0, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{0, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 4, 5\}$ and $L(v_5) = \{0, 5\}$, but then Fixer can edge-color the graph.

**Case 87.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{1, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 4, 5\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph.

**Case 88.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{2, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 4, 5\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph.

**Case 89.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{3, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{3, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 4, 5\}$ and $L(v_5) = \{3, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph.

**Case 90.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{4, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 4, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{3, 5\}$, but then Fixer can edge-color the graph.

**Case 91.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{5, 6\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{5, 6\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 5\}$ and $L(v_5) = \{5, 6\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists

$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,4,5\}$ and $L(v_5) = \{5,6\}$, but then Fixer can edge-color the graph.

**Case 92.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,2\}$ *and* $L(v_5) = \{0,2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 15.

**Case 93.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,2\}$ *and* $L(v_5) = \{2,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1,2\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins by Case 11. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins by Case 12. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,3\}$, but then Fixer wins by Case 6.

**Case 94.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,3\}$ *and* $L(v_5) = \{2,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins by Case 8. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph.

**Case 95.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{1,2,3\}$ *and* $L(v_5) = \{0,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 1 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{1,3\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer wins by Case 8. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 1 at $v_3$. This results in a position with

lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 1 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph.

**Case 96.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 13. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph.

**Case 97.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 21. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 18. If the components of $A_S$ have vertex

sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 14. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 4. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 18. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 14. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 18. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 14.

**Case 98.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 2\}$

and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 20. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 16. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 20. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 16. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 20. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 16.

**Case 99.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 28. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 26. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 19.

**Case 100.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 17. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 3\}$ and

$L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 101.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 15. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph.

**Case 102.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 21. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 103.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 1. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 1. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 1. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 6. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists

$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 6. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 6. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 21. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph.

**Case 104.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 1 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 1 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 1 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer wins by Case 29.

**Case 105.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,3\}$ *and* $L(v_5) = \{2,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{1,2\}$, but then Fixer wins by Case 24.

**Case 106.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,2\}$ *and* $L(v_5) = \{1,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,3\}$, but then Fixer wins by Case 30. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph.

**Case 107.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,2,3\}$ *and* $L(v_5) = \{1,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 1 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 1 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 1 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer wins by Case 25.

**Case 108.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,2,3\}$ *and* $L(v_5) = \{2,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins by Case 18. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins

by Case 20. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 29.

**Case 109.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 4\}$ *and* $L(v_5) = \{2, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 4\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 36.

**Case 110.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ *and* $L(v_5) = \{2, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 4\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 32. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 111.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ *and* $L(v_5) = \{0, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer wins by Case 41.

**Case 112.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ *and* $L(v_5) = \{0, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{1, 2, 4\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$

and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 39. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 113.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 46. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 49.

**Case 114.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 4\}$, but then Fixer wins by Case 51.

**Case 115.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 52.

**Case 116.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ *and* $L(v_5) = \{0,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,4\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,3\}$, but then Fixer wins by Case 51. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,4\}$, but then Fixer can edge-color the graph.

**Case 117.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,4\}$ *and* $L(v_5) = \{0,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{0,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{0,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{0,4\}$, but then Fixer wins by Case 54.

**Case 118.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,4\}$ *and* $L(v_5) = \{1,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 57. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph.

**Case 119.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,4\}$ *and* $L(v_5) = \{2,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{2,4\}$,

but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 56.

**Case 120.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 55. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph.

**Case 121.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 67. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 67. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results

in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer wins by Case 57. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer wins by Case 57. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer wins by Case 57.

**Case 122.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 39. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 39. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 39. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex

sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 38. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 38.

**Case 123.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 38. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 38. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 38. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$

and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 39. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 39.

**Case 124.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 42.

**Case 125.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a

position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 43. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 126.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ *and* $L(v_5) = \{3, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 44.

**Case 127.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ *and* $L(v_5) = \{1, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 3\}$, but then Fixer wins by Case 59. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph.

**Case 128.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ *and* $L(v_5) = \{1, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 4. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 4 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 4 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 4 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 72.

**Case 129.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ *and* $L(v_5) = \{0,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,3\}$, but then Fixer wins by Case 65. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 41.

**Case 130.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ *and* $L(v_5) = \{2,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 40. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 69.

**Case 131.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,2,3\}$ *and* $L(v_5) = \{3,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer wins by Case 57. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{2,3,4\}$

and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 57. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 67. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 67. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 67.

**Case 132.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 4. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 4 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 4 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 4 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer wins by Case 64.

**Case 133.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a

position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer wins by Case 75. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,4\}$, but then Fixer can edge-color the graph.

**Case 134.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{3,4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer wins by Case 76. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer can edge-color the graph.

**Case 135.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{4,5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{4,5\}$, but then Fixer wins by Case 80.

**Case 136.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{4,5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{4,5\}$, but then Fixer wins by Case 78. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph.

**Case 137.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,3,5\}$ *and* $L(v_5) = \{3,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 4 and 5. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 4 and 5 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,5\}$, $L(v_4) = \{2,3,5\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 4 and 5 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 4 and 5 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,3,5\}$ and $L(v_5) = \{3,5\}$, but then Fixer wins by Case 89.

**Case 138.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,4,5\}$ *and* $L(v_5) = \{3,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 5. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 5 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,5\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,4,5\}$ and $L(v_5) = \{3,4\}$, but then Fixer wins by Case 84. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 3 and 5 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 5 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,4,5\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph.

**Case 139.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,3\}$ *and* $L(v_5) = \{0,2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 104.

**Case 140.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,3\}$ *and* $L(v_5) = \{1,2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,3\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{1,2\}$,

but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 16.

**Case 141.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 3\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 106. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph.

**Case 142.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 3. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 12. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 12. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 12. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with

lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 143.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 123. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 144.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 122. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_1\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 145.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,4\}$ *and* $L(v_5) = \{0,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{1,3,4\}$ and $L(v_5) = \{0,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer wins by Case 124.

**Case 146.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,4\}$ *and* $L(v_5) = \{1,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 159. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{1,3,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer can edge-color the graph.

**Case 147.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,4\}$ *and* $L(v_5) = \{2,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 126. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{1,3,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph.

**Case 148.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,2,4\}$ *and* $L(v_5) = \{0,2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{2,3,4\}$

and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 128.

**Case 149.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 110. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 150.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 111.

**Case 151.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 112. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph.

**Case 152.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with

lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 4\}$, but then Fixer wins by Case 114.

**Case 153.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 3\}$ *and* $L(v_5) = \{2, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 115.

**Case 154.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ *and* $L(v_5) = \{2, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 118. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph.

**Case 155.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ *and* $L(v_5) = \{0, 1\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 116.

**Case 156.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,3,4\}$ *and* $L(v_5) = \{0,2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,3,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 116. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,3,4\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph.

**Case 157.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{2,3,4\}$ *and* $L(v_5) = \{1,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 4 at $v_0$. This results in a position with lists $L(v_1) = \{0,4\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{1,3\}$, but then Fixer wins by Case 115. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_4\}$, then Fixer should swap 1 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer wins by Case 57.

**Case 158.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{2,3,4\}$ *and* $L(v_5) = \{2,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,3,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{0,3\}$, but then Fixer wins by Case 121.

**Case 159.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,2,4\}$ *and* $L(v_5) = \{0,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,4\}$, but then Fixer wins by Case 41. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,4\}$,

but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 160.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 3\}$, but then Fixer wins by Case 109.

**Case 161.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 4 at $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer wins by Case 123. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 1 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 131.

**Case 162.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 131.

**Case 163.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with

lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 132.

**Case 164.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer wins by Case 112. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer wins by Case 75.

**Case 165.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{3, 4\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 133. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 166.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{4, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer wins by Case 136. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{1, 3, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph.

**Case 167.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,4\}$ *and* $L(v_5) = \{4,5\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{4,5\}$, but then Fixer wins by Case 135.

**Case 168.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,3,5\}$ *and* $L(v_5) = \{2,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,3,4\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,3,5\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{3,4,5\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,3,5\}$ and $L(v_5) = \{3,4\}$, but then Fixer wins by Case 137.

**Case 169.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{3,4,5\}$ *and* $L(v_5) = \{2,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{3,4\}$, $L(v_4) = \{3,4,5\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 138. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,4,5\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{3,4,5\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph.

**Case 170.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,3,4\}$ *and* $L(v_5) = \{0,2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,3,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins by Case 151. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,3,4\}$ and

$L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 171.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 4\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 31. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 146.

**Case 172.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 4\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer wins by Case 145.

**Case 173.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{1, 3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer wins by Case 125.

**Case 174.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with

lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 152.

**Case 175.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ *and* $L(v_5) = \{0, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 154. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 176.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ *and* $L(v_5) = \{1, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 198.

**Case 177.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ *and* $L(v_5) = \{2, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer wins by Case 197. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 178.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,2,4\}$ *and* $L(v_5) = \{0,1\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 155. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 155. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 155. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and

$L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 179.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 148. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 180.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 153. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 154.

**Case 181.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 3\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 3\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 197.

**Case 182.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with

lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 3\}$, but then Fixer wins by Case 157.

**Case 183.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 111.

**Case 184.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 4 at $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 164. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 1 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 185.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 3, 4\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 4 at $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 3, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 190. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 1 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 3, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 186.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,4\}$ *and* $L(v_5) = \{2,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,3\}$, but then Fixer wins by Case 156. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph.

**Case 187.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{1,2,4\}$ *and* $L(v_5) = \{2,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,3\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{1,3\}$, but then Fixer wins by Case 185. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,3\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph.

**Case 188.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,4\}$ *and* $L(v_5) = \{2,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 151. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,3,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 165.

**Case 189.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,2,4\}$ *and* $L(v_5) = \{1,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 1 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 164. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 1 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{1,4\}$,

but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 1 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 190.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 3, 4\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 149. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 149. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 149. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 76. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 76. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results

in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,3,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,3,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer can edge-color the graph.

**Case 191.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{4,5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{4,5\}$, but then Fixer wins by Case 167.

**Case 192.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{2,4,5\}$ and $L(v_5) = \{2,3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{3,4\}$, $L(v_4) = \{2,4,5\}$ and $L(v_5) = \{3,4\}$, but then Fixer wins by Case 169. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{3,4\}$, $L(v_4) = \{2,4,5\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{2,4,5\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph.

**Case 193.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 179. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 179. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 179. If the components of $A_S$ have vertex

sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 172. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 172. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 172.

**Case 194.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{1, 3, 4\}$

and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 201.

**Case 195.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{1, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{1, 3\}$, but then Fixer wins by Case 184. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_1\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 196.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 158. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 158. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a

position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins by Case 180. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins by Case 180. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins by Case 180.

**Case 197.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{0,4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 1 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{0,4\}$, but then Fixer wins by Case 48. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 1 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,4\}$, but then Fixer wins by Case 47. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 1 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,4\}$, but then Fixer wins by Case 198.

**Case 198.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{1,4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 1 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 47. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 1 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 48. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 1 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 197.

**Case 199.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{0,1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 3\}$, but then Fixer wins by Case 182.

**Case 200.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 199.

**Case 201.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 194.

**Case 202.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 1 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 157. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 1 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 121. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should

swap 0 and 1 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{1,3\}$, but then Fixer wins by Case 128.

**Case 203.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,3\}$, but then Fixer wins by Case 42. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,3\}$, but then Fixer wins by Case 38. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer wins by Case 161.

**Case 204.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,4\}$, but then Fixer wins by Case 111. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,4\}$, but then Fixer wins by Case 68.

**Case 205.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 4 at $v_0$. This results in a position with lists $L(v_1) = \{0,4\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 124. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 122. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 189.

**Case 206.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 1 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer wins by Case 161. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 1 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer wins

by Case 67. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 1 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer wins by Case 72.

**Case 207.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 219. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 219. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 219. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 3, 4\}$

and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph.

**Case 208.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 187. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 187. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 187. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 60. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 60. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 60. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{2, 3, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results

in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph.

**Case 209.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 155. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 155. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 155. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex

sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 172.

**Case 210.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 110. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 110. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 110. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$

and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 171. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 171.

**Case 211.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 199. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 199. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results

in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 205. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 205. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 205.

**Case 212.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,3,4\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 205.

**Case 213.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{1,3,4\}$ and $L(v_5) = \{0,3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 1 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,3,4\}$ and $L(v_5) = \{1,3\}$, but then Fixer wins by Case 195. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 1 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,3,4\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$

and $\{v_2, v_3\}$, then Fixer should swap 0 and 1 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3\}$, $L(v_4) = \{1, 3, 4\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph.

**Case 214.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ *and* $L(v_5) = \{1, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 195.

**Case 215.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ *and* $L(v_5) = \{0, 1\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 216. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 216.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ *and* $L(v_5) = \{0, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 220. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and

$L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 220. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 119. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 119. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 119.

**Case 217.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 1 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 219. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 1 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 1 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 218.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,2,4\}$ *and* $L(v_5) = \{1,2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{1,2\}$, but then Fixer wins by Case 202. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3\}$, $L(v_4) = \{2,3,4\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph.

**Case 219.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,4\}$ *and* $L(v_5) = \{0,2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 207. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 207. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 207. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 178. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and

$L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 220.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 216. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 216. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results

in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 130. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 130. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{1,2,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4\}$, $L(v_4) = \{0,1,2\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 130.

**Case 221.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 202. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 202. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 202. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2\}$, $L(v_4) = \{0,2,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex

sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 184. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 184.

**Case 222.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 3\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 180.

**Case 223.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 1 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 199. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 1 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins

by Case 155. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 1 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 184.

**Case 224.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 196. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{1, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 217. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 184.

**Case 225.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 178. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 214. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2\}$, $L(v_4) = \{0, 2, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 223.

□

**Lemma 2.** *Fixer has a winning strategy against Breaker in the chronicled game on $P_5$ with superabundant list assignment $L$ where $|L(v_1)| = 2$, $|L(v_2)| = 3$, $|L(v_3)| = 3$, $|L(v_4)| = 2$ and $|L(v_5)| = 2$.*

*Proof.* We show that for each possible such list assignment $L$ on $G$, Fixer has a winning strategy. Up to symmetry, the following cases cover all the possible list assignments.

**Case 1.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 3\}$ and

$L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph.

**Case 2.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 3 at $v_3$ and $v_1$. This results

in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph.

**Case 3.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{0,2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{1,2,3\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{1,2,3\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{1,2,3\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{1,2,3\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{1,2,3\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{1,2,3\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 4.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 5.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 6.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_0$. This results

in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 7.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 8.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 9.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 1 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 1 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 1 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 10.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and

$L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 11.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 1 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 1 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 1 at $v_4$. This results in a position with lists

$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{1,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph.

**Case 12.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{1,3\}$ *and* $L(v_5) = \{2,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,3\}$, $L(v_4) = \{1,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{1,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph.

**Case 13.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ *and* $L(v_5) = \{0,1\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph.

**Case 14.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ *and* $L(v_5) = \{0,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph.

**Case 15.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{1,2\}$ *and* $L(v_5) = \{0,1\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$

and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph.

**Case 16.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph.

**Case 17.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{0,1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,1\}$

and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph.

**Case 18.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph.

**Case 19.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results

in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph.

**Case 20.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{1,2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 21.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph.

**Case 22.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{1, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 23.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph.

**Case 24.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$. This results in

a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 25.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 1 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 1 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 1 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 26.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 27.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 28.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 1 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 1 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 1 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 29.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 30.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_2$. This results

in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{1,3,4\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,3\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,3\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,3\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,3\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph.

**Case 31.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{0,4\}$ and $L(v_5) = \{0,3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,4\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{0,4\}$ and $L(v_5) = \{0,4\}$, but then Fixer can edge-color the graph.

**Case 32.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{2,3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph.

**Case 33.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{0,3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,4\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex

sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 4\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 4\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 34.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 4\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 4\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 4\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 35.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 36.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{1, 2, 4\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph.

**Case 37.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 4 at $v_4$ and $v_1$. This results in

a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,4\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{1,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,3\}$, $L(v_4) = \{1,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,3\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,3\}$, $L(v_4) = \{1,3\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{1,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,3\}$, $L(v_4) = \{1,3\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,3\}$, $L(v_4) = \{1,3\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{1,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{1,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph.

**Case 38.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{3,4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,4\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 4\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 4\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 39.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 3\}$ and

$L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 40.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 4\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 4\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 4\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_2$. This results

in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph.

**Case 41.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{3,4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,4\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph.

**Case 42.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,4\}$, but then Fixer can edge-color the graph.

**Case 43.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$

and $\{v_0, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 44.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 3\}$ *and* $L(v_5) = \{3, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 45.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 4\}$ *and* $L(v_5) = \{0, 1\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 4. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 4 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 4 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 4 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 46.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 4\}$ *and* $L(v_5) = \{0, 1\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and

$L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph.

**Case 47.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists

$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 48.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 49.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph.

**Case 50.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 51.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 52.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$

and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 53.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{1, 3, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph.

**Case 54.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 4. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 4 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 4 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 4 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 55.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results

in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 56.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 57.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 58.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 59.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 60.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in

a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph.

**Case 61.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex

sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 62.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 63.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and

$L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 64.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in

a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 65.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 4. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 4 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 4 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 4 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 66.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$

and $\{v_1, v_4\}$, then Fixer should swap 2 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 67.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph.

**Case 68.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 69.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 70.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 1 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 1 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 1 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph.

**Case 71.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ *and* $L(v_5) = \{0, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 72.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{3, 4\}$ *and* $L(v_5) = \{0, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 73.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 1\}$ *and* $L(v_5) = \{1, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in

a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 74.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$

and $\{v_1, v_4\}$, then Fixer should swap 2 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 75.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph.

**Case 76.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 2\}$ and

$L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 77.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 78.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 1 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 1 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 1 at $v_4$ and $v_1$. This results

in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 79.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 80.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 81.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$

and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph.

**Case 82.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 4. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 4 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 4 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 4 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 83.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_0$. This results

in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 84.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{1, 3, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 3, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 3, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 3, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 3, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph.

**Case 85.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{3, 5\}$ *and* $L(v_5) = \{3, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 4 and 5. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 4 and 5 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 5\}$, $L(v_4) = \{3, 5\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 4 and 5 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 4 and 5 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{3, 5\}$ and $L(v_5) = \{3, 5\}$, but then Fixer can edge-color the graph.

**Case 86.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 5\}$ *and* $L(v_5) = \{3, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 4 and 5. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 4 and 5 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 5\}$, $L(v_4) = \{3, 5\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 4 and 5 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 4 and 5 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 5\}$ and $L(v_5) = \{3, 5\}$, but then Fixer can edge-color the graph.

**Case 87.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ *and* $L(v_5) = \{4, 5\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph.

**Case 88.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ *and* $L(v_5) = \{0, 5\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 5\}$, but then Fixer can edge-color the graph.

**Case 89.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$. This results in

a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph.

**Case 90.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph.

**Case 91.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{0, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{0, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{0, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{0, 5\}$, but then Fixer can edge-color the graph.

**Case 92.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{1, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph.

**Case 93.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{2, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph.

**Case 94.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{4, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph.

**Case 95.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 5\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 4 and 5. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 4 and 5 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 5\}$, $L(v_4) = \{0, 5\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 4 and 5 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 4 and 5 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 5\}$ and $L(v_5) = \{0, 5\}$, but then Fixer can edge-color the graph.

**Case 96.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 5. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 5 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 5 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 5 at $v_3$ and $v_2$. This results in

a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 5 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 5 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 5 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 5 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 5 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 5 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 5 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 5 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 5 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 5 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 5 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 5 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph.

**Case 97.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 5\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 4 and 5. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 4 and 5 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 5\}$, $L(v_4) = \{1, 5\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$

and $\{v_2, v_4\}$, then Fixer should swap 4 and 5 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 4 and 5 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 5\}$ and $L(v_5) = \{1, 5\}$, but then Fixer can edge-color the graph.

**Case 98.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 5. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 5 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 5\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 5 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 5\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 5 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 5\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph.

**Case 99.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 5\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 4 and 5. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 4 and 5 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 5\}$, $L(v_4) = \{2, 5\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 4 and 5 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 4 and 5 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 5\}$ and $L(v_5) = \{2, 5\}$, but then Fixer can edge-color the graph.

**Case 100.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 5. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 5 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 5\}$, $L(v_3) = \{3, 4, 5\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 5 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 5\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 5 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 5\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph.

**Case 101.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 3, 5\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 102.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{4, 5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 5. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 5 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 5 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 5 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 5 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 5 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 5 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 5 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 5 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 5 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 5 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 5 at $v_2$. This results

in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,4\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 5 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4,5\}$, $L(v_4) = \{4,5\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 5 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4,5\}$, $L(v_4) = \{0,4\}$ and $L(v_5) = \{0,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 5 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4,5\}$, $L(v_4) = \{4,5\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 5 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4,5\}$, $L(v_4) = \{0,4\}$ and $L(v_5) = \{0,4\}$, but then Fixer can edge-color the graph.

**Case 103.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4,5\}$, $L(v_4) = \{1,4\}$ and $L(v_5) = \{4,5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 5. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 5 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,5\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,4\}$, $L(v_4) = \{1,4\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 5 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,5\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4,5\}$, $L(v_4) = \{4,5\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 5 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,5\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4,5\}$, $L(v_4) = \{1,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer can edge-color the graph.

**Case 104.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4,5\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{4,5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 5. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 5 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,3,5\}$, $L(v_3) = \{2,4,5\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 5 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4,5\}$, $L(v_4) = \{4,5\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 5 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4,5\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph.

**Case 105.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,4,5\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{4,5\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 5. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 3 and 5 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,5\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{4,5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have

vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 5 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 5\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 5 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 5\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 106.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{4, 5\}$ *and* $L(v_5) = \{5, 6\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{5, 6\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{5, 6\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{5, 6\}$, but then Fixer can edge-color the graph.

**Case 107.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{4, 6\}$ *and* $L(v_5) = \{4, 5\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 5 and 6. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 5 and 6 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 6\}$, $L(v_4) = \{4, 6\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 5 and 6 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{4, 5\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 5 and 6 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{4, 6\}$ and $L(v_5) = \{4, 6\}$, but then Fixer can edge-color the graph.

**Case 108.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 3\}$ *and* $L(v_5) = \{0, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 5. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 17.

**Case 109.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 3\}$ *and* $L(v_5) = \{1, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 27. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 110.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 1 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 26. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 1 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 1 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph.

**Case 111.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 4\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 36.

**Case 112.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 4\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 33. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 4 at $v_3$. This results in a position with lists

$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph.

**Case 113.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,3\}$ *and* $L(v_5) = \{2,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1,4\}$, $L(v_2) = \{1,2,4\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins by Case 34. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1,4\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1,4\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph.

**Case 114.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{2,3\}$ *and* $L(v_5) = \{0,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1,4\}$, $L(v_2) = \{1,2,4\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1,4\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1,4\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{3,4\}$, but then Fixer wins by Case 79.

**Case 115.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ *and* $L(v_5) = \{0,1\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,3,4\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 45. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,4\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 55.

**Case 116.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ *and* $L(v_5) = \{0,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,4\}$, but then Fixer wins by Case 65. If the components of $A_S$ have vertex

sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 117.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ *and* $L(v_5) = \{0, 1\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 46. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 58.

**Case 118.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ *and* $L(v_5) = \{1, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 4 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 59. If the components of $A_S$ have vertex sets $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 4 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 119.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ *and* $L(v_5) = \{2, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 36.

**Case 120.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ *and* $L(v_5) = \{0, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer wins by Case 70. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 121.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 4 at $v_0$. This results in a position with lists $L(v_1) = \{0, 4\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 42. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 1 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 4\}$, but then Fixer wins by Case 66.

**Case 122.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 4\}$, but then Fixer wins by Case 66.

**Case 123.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 32. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists

$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 69.

**Case 124.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,3\}$ *and* $L(v_5) = \{0,2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,4\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 51. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph.

**Case 125.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{2,4\}$ *and* $L(v_5) = \{3,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{3,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{0,4\}$, but then Fixer wins by Case 71.

**Case 126.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{3,4\}$ *and* $L(v_5) = \{2,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 83. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph.

**Case 127.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,4\}$, $L(v_4) = \{0,2\}$ *and* $L(v_5) = \{2,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 39. If the components of $A_S$ have vertex sets

$\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 81.

**Case 128.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 2\}$ *and* $L(v_5) = \{1, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 74.

**Case 129.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 3\}$ *and* $L(v_5) = \{1, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 53. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph.

**Case 130.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 4\}$ *and* $L(v_5) = \{3, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 41.

**Case 131.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{3, 4\}$ *and* $L(v_5) = \{2, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 84. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 132.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{2, 4\}$ *and* $L(v_5) = \{3, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 5. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 3 and 5 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 5\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 3 and 5 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 5 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{4, 5\}$, but then Fixer wins by Case 104.

**Case 133.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{3, 4\}$ *and* $L(v_5) = \{2, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 5. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 5 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 5\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 100. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 5 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 5 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{4, 5\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 134.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 4\}$ *and* $L(v_5) = \{0, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{1, 2, 4\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 113. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_0$. This results

in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph.

**Case 135.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 4\}$ *and* $L(v_5) = \{0, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 4\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 112. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 136.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 4\}$ *and* $L(v_5) = \{2, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 126. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph.

**Case 137.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ *and* $L(v_5) = \{1, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 117. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 138.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 2\}$ *and* $L(v_5) = \{2, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$

and $\{v_1, v_3\}$, then Fixer should swap 2 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 119.

**Case 139.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 2\}$ *and* $L(v_5) = \{0, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 117. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph.

**Case 140.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 3\}$ *and* $L(v_5) = \{0, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 122.

**Case 141.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 3\}$ *and* $L(v_5) = \{3, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 125.

**Case 142.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ *and* $L(v_5) = \{1, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 125.

**Case 143.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{1, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 3\}$, but then Fixer wins by Case 114.

**Case 144.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{3, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 3\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 130.

**Case 145.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 113. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists

$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 83.

**Case 146.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 4\}$ *and* $L(v_5) = \{0, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer wins by Case 114. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph.

**Case 147.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ *and* $L(v_5) = \{2, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 124. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph.

**Case 148.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 5\}$ *and* $L(v_5) = \{2, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 5. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 5 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 5\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 5\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 133. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 5 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{3, 4, 5\}$, $L(v_4) = \{2, 5\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 5 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 5\}$ and $L(v_5) = \{3, 5\}$, but then Fixer can edge-color the graph.

**Case 149.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{2, 3\}$ *and* $L(v_5) = \{3, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 4\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$

and $\{v_1, v_3\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 5\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{3, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 3 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{3, 4\}$, but then Fixer wins by Case 132.

**Case 150.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 2\}$ *and* $L(v_5) = \{0, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 143.

**Case 151.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ *and* $L(v_5) = \{1, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_0$. This results in a position with lists $L(v_1) = \{1, 4\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer wins by Case 146. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 4\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph.

**Case 152.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 4\}$ *and* $L(v_5) = \{0, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 134. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 51.

**Case 153.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ *and* $L(v_5) = \{0, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 135. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 3\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 52.

**Case 154.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ *and* $L(v_5) = \{1, 4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 74. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 73. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 118.

**Case 155.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 2\}$ *and* $L(v_5) = \{2, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 182.

**Case 156.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 1\}$ *and* $L(v_5) = \{0, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 134. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists

$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 124.

**Case 157.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{2,3\}$ *and* $L(v_5) = \{2,3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,3,4\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{3,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{3,4\}$, but then Fixer wins by Case 141.

**Case 158.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{1,4\}$ *and* $L(v_5) = \{2,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 1 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{1,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 145. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 1 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,4\}$, $L(v_4) = \{1,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 1 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph.

**Case 159.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,4\}$, $L(v_4) = \{0,2\}$ *and* $L(v_5) = \{0,2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,4\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 153. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,4\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{2,4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex

sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_3$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 153. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 127. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 127. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 127.

**Case 160.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 187.

**Case 161.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 182.

**Case 162.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 129. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 3, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph.

**Case 163.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 4 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{2, 4, 5\}$, $L(v_4) = \{3, 4\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 149.

**Case 164.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 152. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 3\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 45. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_1\}$, then Fixer should

swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,3\}$, $L(v_4) = \{0,4\}$ and $L(v_5) = \{0,3\}$, but then Fixer wins by Case 29.

**Case 165.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1,v_2\}$ and $\{v_3,v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1,v_3\}$ and $\{v_2,v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1,v_4\}$ and $\{v_2,v_3\}$, then Fixer should swap 0 and 3 at $v_0$, $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins by Case 135. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0,v_2\}$ and $\{v_3,v_4\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0,v_3\}$ and $\{v_2,v_4\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0,v_4\}$ and $\{v_2,v_3\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0,v_1\}$ and $\{v_3,v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0,v_1\}$ and $\{v_2,v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0,v_1\}$ and $\{v_2,v_3\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins by Case 39. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0,v_3\}$ and $\{v_1,v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0,v_4\}$ and $\{v_1,v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0,v_2\}$ and $\{v_1,v_4\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0,v_2\}$ and $\{v_1,v_3\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins by Case 39. If the components of $A_S$ have vertex

sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 39.

**Case 166.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 29. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 30. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 183.

**Case 167.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 151.

**Case 168.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{1, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 151.

**Case 169.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{0, 4\}$, but then Fixer wins by Case 170.

**Case 170.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 142. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 64. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 4\}$, but then Fixer wins by Case 60. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 158. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$.

This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{1,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 158. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0,v_2\}$ and $\{v_1,v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 64. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0,v_2\}$ and $\{v_1,v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{1,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 60. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0,v_4\}$ and $\{v_1,v_2\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 64. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0,v_3\}$ and $\{v_1,v_2\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{1,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 60.

**Case 171.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 3 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2,v_4\}$, then Fixer should swap 3 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,4\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1,v_4\}$, then Fixer should swap 3 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,3\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1,v_2\}$, then Fixer should swap 3 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 179.

**Case 172.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2,v_4\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,4\}$, but then Fixer wins by Case 138. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0,v_4\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,4\}$, but then Fixer wins by Case 116. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0,v_2\}$, then Fixer should swap 0 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 127.

**Case 173.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{1,2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0,v_1\}$ and $\{v_2,v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0,v_2\}$ and $\{v_1,v_4\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results

in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins by Case 167.

**Case 174.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{1,3\}$ and $L(v_5) = \{0,3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 4 at $v_0$. This results in a position with lists $L(v_1) = \{1,4\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{1,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer wins by Case 145. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,4\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{1,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer wins by Case 78. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_1\}$, then Fixer should swap 0 and 4 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{1,3\}$ and $L(v_5) = \{3,4\}$, but then Fixer wins by Case 37.

**Case 175.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,3\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{2,3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,3\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins by Case 135. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{1,2,3\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins by Case 32. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,3\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{1,2\}$, but then Fixer wins by Case 54.

**Case 176.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{1,4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 78. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,4\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 79. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 168.

**Case 177.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{0,1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$

and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_3\}$, then Fixer should swap 0 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,2\}$, but then Fixer wins by Case 178.

**Case 178.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 4. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 4 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,4\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 4 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0,4\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 4 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0,4\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{2,4\}$, but then Fixer wins by Case 166.

**Case 179.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 4. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 4 at $v_0$. This results in a position with lists $L(v_1) = \{0,4\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 48. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,2\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 43. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_2\}$, then Fixer should swap 1 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{2,4\}$ and $L(v_5) = \{1,4\}$, but then Fixer wins by Case 142.

**Case 180.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{1,2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 3. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 2 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 2 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{1,3\}$, but then Fixer wins by Case 181.

**Case 181.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,3,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{1,3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{1, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 159.

**Case 182.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 187. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 39. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 35.

**Case 183.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 30. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_0, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 29. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_0, v_1\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{2, 4\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 166.

**Case 184.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$

and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 157. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 157. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 193. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 193. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 193.

**Case 185.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 1 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 156. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 1 at $v_2$. This results in a position with

lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{1,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 1 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph.

**Case 186.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 198. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 198. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 198. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{1,2,3\}$, $L(v_3) = \{2,3,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex

sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 197. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{1, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 197.

**Case 187.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ *and* $L(v_5) = \{0, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 182. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 35. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{2, 3, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 39.

**Case 188.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ *and* $L(v_5) = \{0, 2\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 1\}$

and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 156. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 192. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 199. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 156. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 156. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 192. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 199. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 192. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 199.

**Case 189.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{0, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 1 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 167. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 1 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 2\}$, but then Fixer wins by Case 192. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 0 and 1 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 184.

**Case 190.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{1, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 1 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 198. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 1 at $v_2$. This results in a position with lists

$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,4\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{1,3\}$, but then Fixer wins by Case 143. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 1 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{2,3\}$ and $L(v_5) = \{0,3\}$, but then Fixer wins by Case 140.

**Case 191.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{1,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 167. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 115. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{1,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 195.

**Case 192.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 164. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results

in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 115. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 188. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 115. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 188. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 115.

**Case 193.** *$L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{2,3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,3\}$, $L(v_2) = \{0,1,2\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{1,2\}$ and $L(v_5) = \{2,3\}$, but then Fixer wins by Case 190. If the components of $A_S$ have vertex

sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 3\}$, but then Fixer wins by Case 190. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 184. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 184. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 184.

**Case 194.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 4\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 2 and 4. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 2 and 4 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 3, 4\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 2 and 4 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 2\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{2, 4\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 2 and 4 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{1, 4\}$ and $L(v_5) = \{2, 4\}$, but then Fixer wins by Case 170.

**Case 195.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{1, 2\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 115. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_0, v_4\}$, then Fixer should swap 0 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins

by Case 167. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_0, v_2\}$, then Fixer should swap 0 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 191.

**Case 196.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 192. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 192. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 192. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$

and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 199.

**Case 197.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 185. If the components of $A_S$ have vertex sets $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer wins by Case 184. If the components of $A_S$ have vertex sets $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 0 and 2 at $v_4$ and $v_0$. This results in a position with lists $L(v_1) = \{1, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{1, 2\}$ and $L(v_5) = \{1, 2\}$, but then Fixer wins by Case 199.

**Case 198.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 3\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 0 and 1. If the components of $A_S$ have vertex sets $\{v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 0 and 1 at $v_4$ and $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer wins by Case 190. If the components of $A_S$ have vertex sets $\{v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 0 and 1 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 140. If the components of $A_S$ have vertex sets $\{v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 0 and 1 at $v_4$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{1, 2, 4\}$, $L(v_4) = \{2, 3\}$ and $L(v_5) = \{1, 3\}$, but then Fixer wins by Case 143.

**Case 199.** *$L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$.*

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results

in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 115. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,1\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 115. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 188. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,2\}$ and $L(v_5) = \{0,1\}$, but then Fixer wins by Case 115. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_4$. This results in a position with lists $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,2\}$, but then Fixer wins by Case 188.

**Case 200.** $L(v_1) = \{0,1\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,1\}$ *and* $L(v_5) = \{0,4\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 2. If the components of $A_S$ have vertex sets $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 2 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,1,3\}$, $L(v_3) = \{0,1,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,4\}$, but then Fixer wins by Case 66. If the components of $A_S$ have vertex sets $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 2 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0,2\}$, $L(v_2) = \{0,2,3\}$, $L(v_3) = \{0,2,4\}$, $L(v_4) = \{0,1\}$ and $L(v_5) = \{0,4\}$, but then Fixer wins by Case 29. If the components of $A_S$ have vertex

sets $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 2 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 2\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 2\}$ and $L(v_5) = \{0, 4\}$, but then Fixer wins by Case 201.

**Case 201.** $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ *and* $L(v_5) = \{0, 3\}$.

Let $S$ and $A_S$ be as in Lemma 3 using colors 1 and 3. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 115. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 115. If the components of $A_S$ have vertex sets $\{v_0\}$, $\{v_1, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 115. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_2\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 156. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_3\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 156. If the components of $A_S$ have vertex sets $\{v_1\}$, $\{v_0, v_4\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 156. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_1\}$ and $\{v_3, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_1\}$ and $\{v_2, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_1\}$ and $\{v_2, v_3\}$, then Fixer should swap 1 and 3 at $v_1$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 2, 3\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 164. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_3\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_2\}$, $\{v_0, v_4\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_2\}$ and $\{v_1, v_4\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_2\}$ and $\{v_1, v_3\}$, then Fixer should swap 1 and 3 at $v_2$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 1, 4\}$, $L(v_4) = \{0, 1\}$

and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 121. If the components of $A_S$ have vertex sets $\{v_3\}$, $\{v_0, v_4\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$. This results in a position with lists $L(v_1) = \{0, 1\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer can edge-color the graph. If the components of $A_S$ have vertex sets $\{v_4\}$, $\{v_0, v_3\}$ and $\{v_1, v_2\}$, then Fixer should swap 1 and 3 at $v_3$ and $v_0$. This results in a position with lists $L(v_1) = \{0, 3\}$, $L(v_2) = \{0, 1, 2\}$, $L(v_3) = \{0, 3, 4\}$, $L(v_4) = \{0, 3\}$ and $L(v_5) = \{0, 3\}$, but then Fixer wins by Case 199.

□

**Lemma 3.** *Let $G$ be a multigraph, $L$ a list assignment on $G$ and $\alpha, \beta \in \mathrm{Pot}(L)$. Let $S \subseteq V(G)$ be those vertices $v$ with $|\{\alpha, \beta\} \cap L(v)| = 1$. Then there is a graph $A_S$ with vertex set $S$ and $\Delta(A_S) \leq 1$ such that Fixer has a sequence of moves against Breaker in the chronicled game resulting in a list assignment where Fixer has chosen to swap $\alpha$ and $\beta$ all or none of the vertices in each component of $A_S$.*

*Proof.* For each $v \in S$, Fixer should swap $\alpha$ and $\beta$ at $v$ twice in a row. Now every $v \in S$ is incident to an edge in $\mathcal{C}$; that is, as long as Fixer only does swaps with $\alpha$ and $\beta$, Breaker's moves are already foretold in the chronicle. Now add an edge in $A_S$ for each $xy \in \mathcal{C} - \infty$ labeled $\{\alpha, \beta\}$. The lemma follows. □