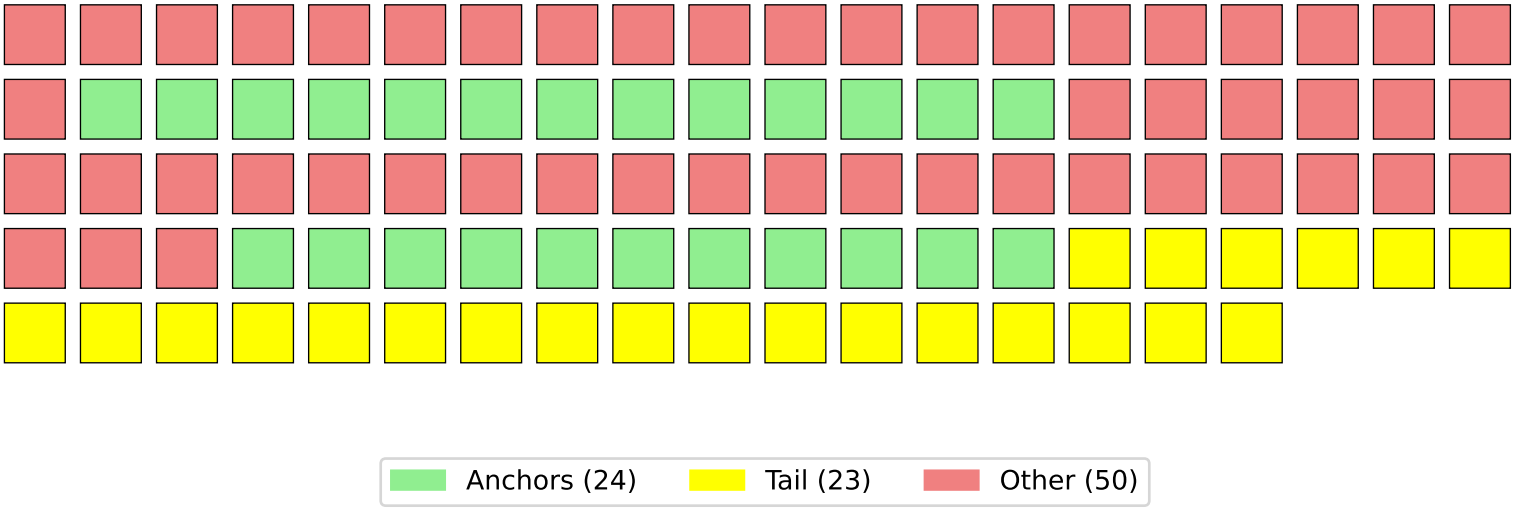
Set-Cover Analysis: Mathematical Constraints

KEY INSIGHT (L=17):

With L=17 and 97 positions, each position maps to a UNIQUE (class, slot) pair.
This creates a 1-to-1 mapping, meaning:
• 24 anchor positions → exactly 24 unique slots determined
• 73 remaining positions → exactly 73 unique slots needed
• Minimal set-cover = 73 (must constrain ALL remaining positions)

97 Positions: Each Maps to Unique Slot



TAIL COVERAGE ANALYSIS:

• Tail region: positions 74-96 (23 positions)
• Under L=17: Each tail position covers exactly 1 unique slot
• Coverage: 23 of 73 needed slots (31.5%)
• Shortfall: 50 additional positions still needed

Mathematical conclusion: The tail alone CANNOT complete the solution.

ALTERNATIVE MECHANISMS:

• L=15: Reduces unknowns to 21 (tail would be sufficient!)
• L=20: Reduces unknowns to 49 (still need 26 beyond tail)
• L=17: Current hypothesis with 73 unknowns

Trade-off: Lower L values reduce unknowns but may violate other constraints.