

- Let  $R \subset \mathbb{Z}$  be the sequence of rows and  $C \subset \mathbb{Z}$  be the sequence of columns.
- Let  $K$  be the domain for modifiers  $K = \{\text{ADJ}, \text{ROW}, \text{COL}\}$ .
- Let  $A_{c,r,k}$  be the solution matrix for column  $c$ , row  $r$  and modifier  $k$ .
- Let  $X$  be a set of points  $(c, r)$  which are a subset of the points in  $A$ . The points represent non-empty cells.
- Let  $\text{hcon}(c, r)$  be the set of horizontally connected cells for  $c, r \in X$  except for  $(c, r)$ .
- Let  $\text{vcon}(c, r)$  be the set of vertically connected cells for  $c, r \in X$  except for  $(c, r)$ .
- Let  $V(c, r) = \{(c-1, r), (c+1, r), (c, r-1), (c, r+1)\} \cap X$  and then
$$\text{adj}(c, r) = \sum_{(c', r') \in V(c, r)} A_{c', r', \text{ADJ}} * 0.4.$$
- Let  $\text{row}(c, r) = \sum_{(c', r') \in \text{hcon}(c, r)} A_{c', r', \text{ROW}} * 0.25.$
- Let  $\text{col}(c, r) = \sum_{(c', r') \in \text{vcon}(c, r)} A_{c', r', \text{COL}} * 0.25.$
- Let  $\text{mul}(c, r) = 1 + \text{adj}(c, r) + \text{row}(c, r) + \text{col}(c, r).$
- Let  $\text{big } M = 2.8.$
- Let  $\text{unmodified}(c, r) = 1 - \left( \sum_{k \in K} A_{c, r, k} \right).$

$$\begin{aligned}
& \text{maximize} && \sum_{(c, r) \in X} w_{c, r} \\
& \text{subject to} && \sum_{k \in K} A_{c, r, k} \leq 1, && \forall (c, r) \in X \\
& && \sum_{k \in K} A_{c, r, k} = 0, && \forall (c, r) \in (C \times R) - X \\
& && w_{c, r} \leq \text{mul}(c, r), && \forall (c, r) \in X \\
& && w_{c, r} \leq M(1 - \sum_{k \in K} A_{c, r, k}), && \forall (c, r) \in X \\
& && \sum_{(c', r') \in V(c, r)} \text{unmodified}(c', r') \geq 3 * A_{c, r, \text{ADJ}}, && \forall (c, r) \in X \\
& && \sum_{(c', r') \in \text{hcon}(c, r)} \text{unmodified}(c', r') \geq 5 * A_{c, r, \text{ROW}}, && \forall (c, r) \in X \\
& && \sum_{(c', r') \in \text{vcon}(c, r)} \text{unmodified}(c', r') \geq 5 * A_{c, r, \text{COL}}, && \forall (c, r) \in X \\
& && A_{c, r, k} \in \{0, 1\}, && \forall (c, r) \in C \times R \\
& && w_{c, r} \in \{0, 1\}, && \forall (c, r) \in X
\end{aligned}$$