
Interactive Depixelization of Pixel Art through Spring Simulation

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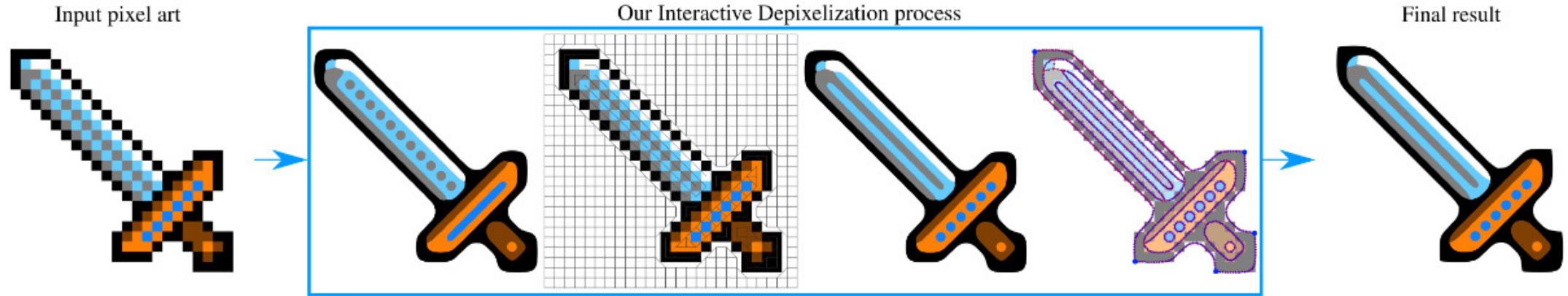
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Context

Vectorization of pixel art image



Contribution:

- Spring simulation based method
- Interactive framework ← **Really important for disambiguation**

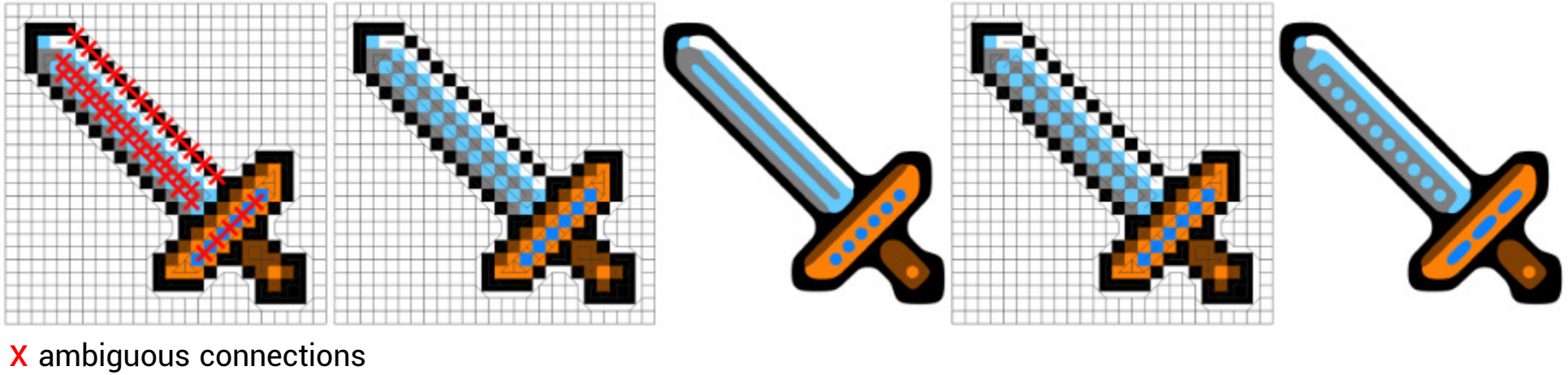
Method

Four steps:

- Clustering ← **User interaction**
- Path generation
- Spring simulation ← **User interaction**
- Optimization

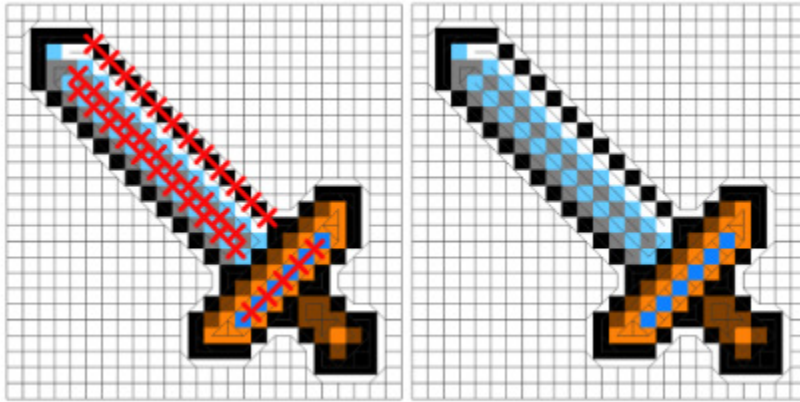
Method - Clustering

Creation of similarity graph

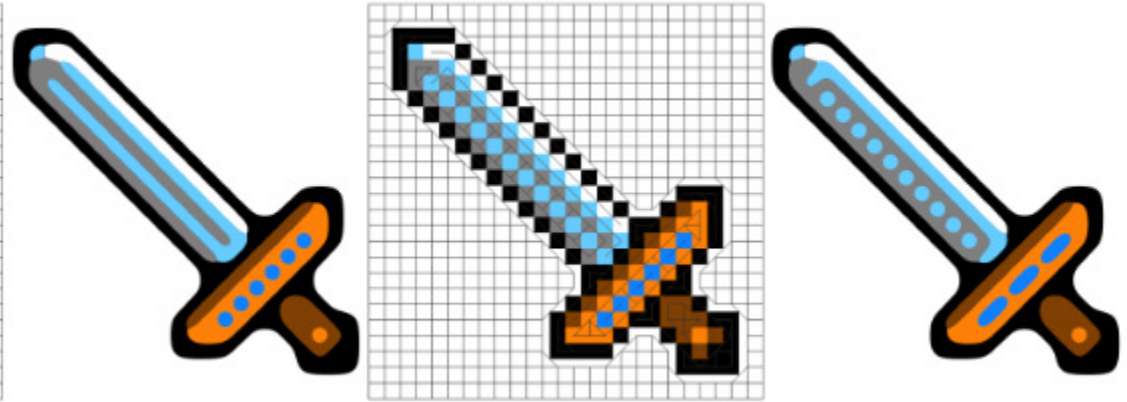


Method - Clustering

Creation of similarity graph



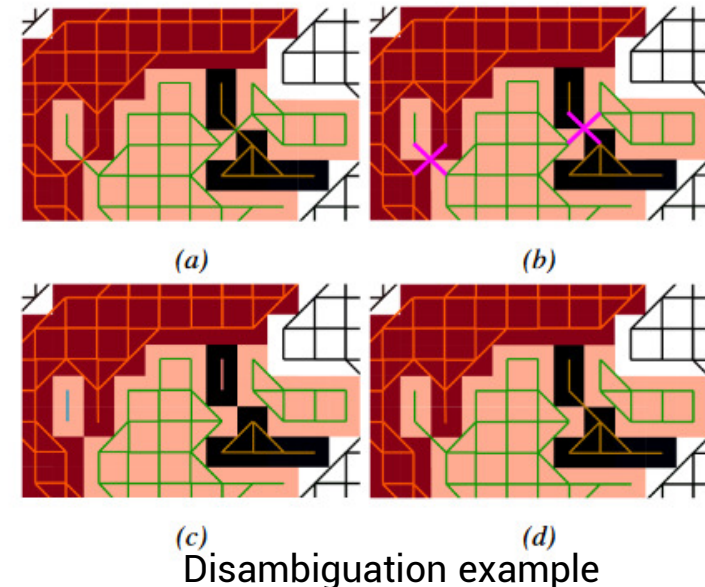
X ambiguous connections



Automatic scheme (default):

For each (a,b) and (c,d)
the intersecting edges

$$G_{new} = G_D + \begin{cases} (a,b), & \text{if } |C_a| \text{ or } |C_b| \text{ is the least} \\ (c,d), & \text{if } |C_c| \text{ or } |C_d| \text{ is the least} \end{cases}$$



Method – Path generation

Creation of path around pixel clusters

- Merge edges nodes
- Process corner nodes

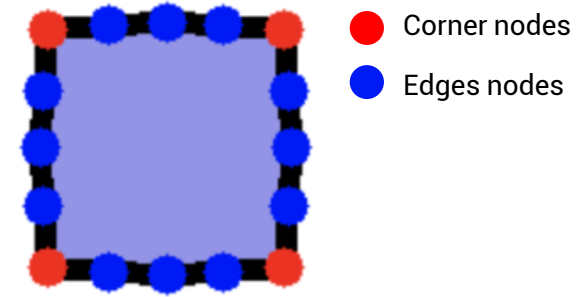


Figure 8: *Corner and Edge nodes*

Standard cases for corner nodes

Method – Path generation

Creation of path around pixel clusters

- Merge edges nodes
- Process corner nodes

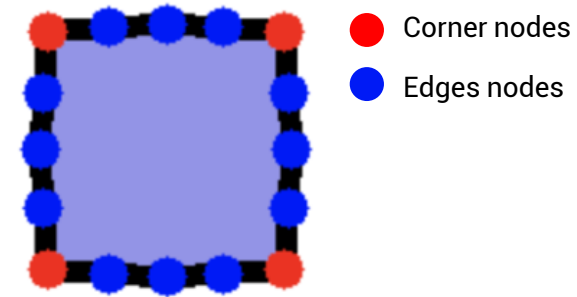
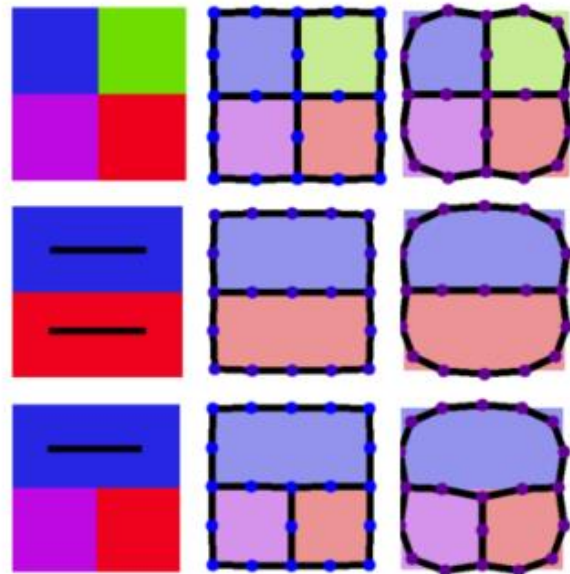
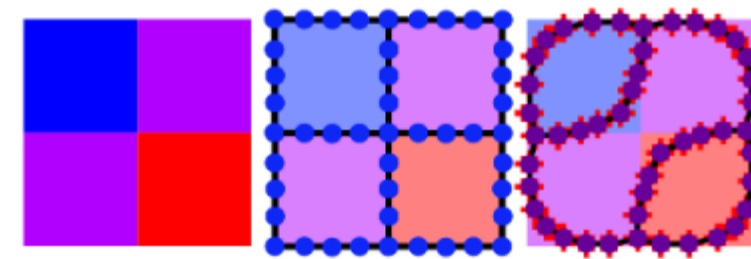


Figure 8: *Corner and Edge nodes*

Corner nodes



Standard cases for corner nodes



Corner nodes with diagonal connection

Method – Spring simulation

Three forces

Method – Spring simulation

Three forces

- Original position $\vec{F}_O = (\vec{P}_O - \vec{P}) \cdot |\vec{P}_O - \vec{P}| \cdot K_O$

Method – Spring simulation

Three forces

- Original position $\vec{F}_O = \left(\vec{P}_O - \vec{P} \right) \cdot \left| \vec{P}_O - \vec{P} \right| \cdot K_O$
- Neighbors $\vec{F}_{Ni} = \left(\vec{P}_{Ni} - \vec{P} \right) \cdot K_N$

Method – Spring simulation

Three forces

- Original position $\vec{F}_O = (\vec{P}_O - \vec{P}) \cdot |\vec{P}_O - \vec{P}| \cdot K_O$
- Neighbors $\vec{F}_{Ni} = (\vec{P}_{Ni} - \vec{P}) \cdot K_N$
- Shape area $\vec{F}_{Ai} = (\vec{P} - \vec{P}_{Ai}) \cdot \left(1 - \sqrt{\frac{Ai}{Ai_O}}\right)$

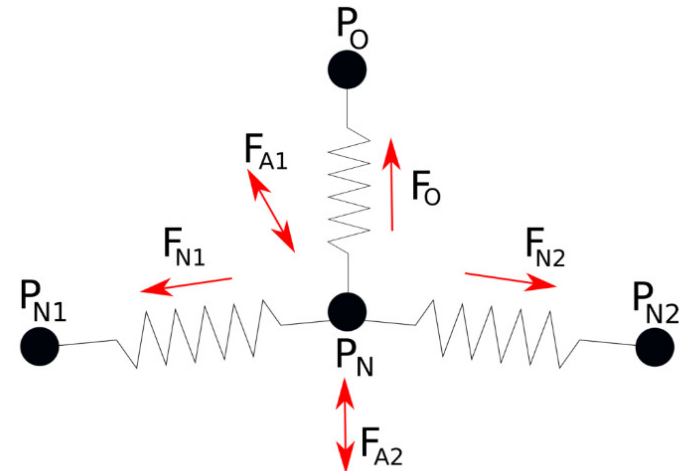
Method – Spring simulation

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Final force

$$\vec{F} = \vec{F}_O + \sum_{i \in Ns} \vec{F}_{Ni} + \sum_{i \in As} \vec{F}_{Ai}$$



Method – Spring simulation

Three forces

- Original position $\vec{F}_O = (\vec{P}_O - \vec{P}) \cdot |\vec{P}_O - \vec{P}| \cdot K_O$
- Neighbors $\vec{F}_{Ni} = (\vec{P}_{Ni} - \vec{P}) \cdot K_N$
- Shape area $\vec{F}_{Ai} = (\vec{P} - \vec{P}_{Ai}) \cdot \left(1 - \sqrt{\frac{A_i}{A_{iO}}}\right)$

Final force

$$\vec{F} = \vec{F}_O + \sum_{i \in Ns} \vec{F}_{Ni} + \sum_{i \in As} \vec{F}_{Ai}$$



Input pixel art



Simulation with F_N alone



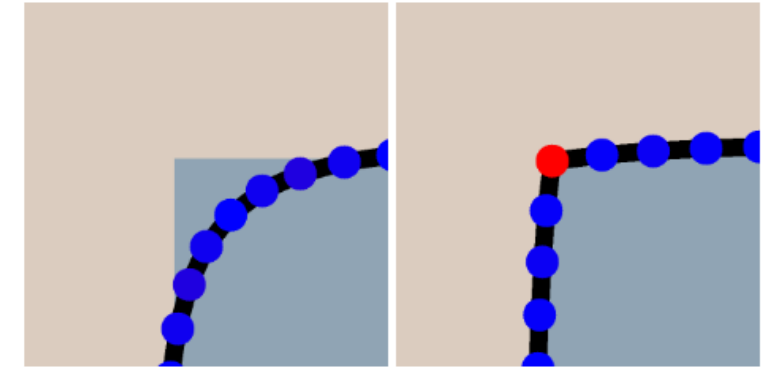
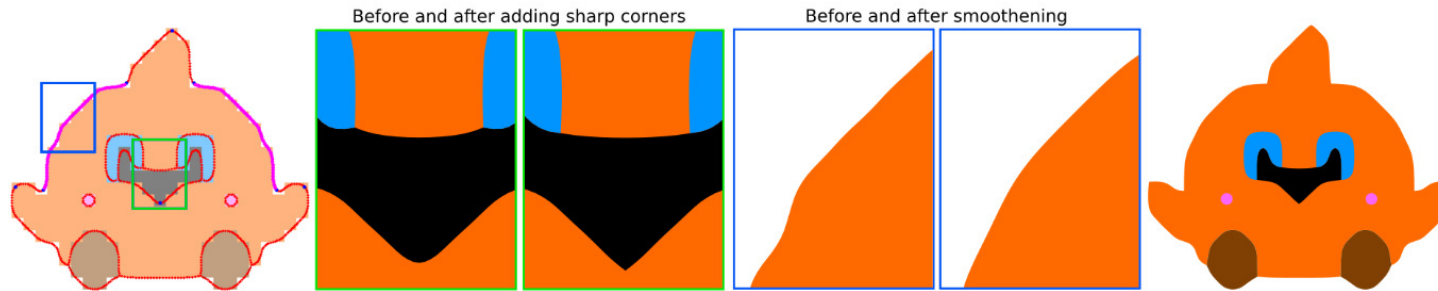
Simulation with F_N and F_O



Simulation with F_N , F_O and F_A

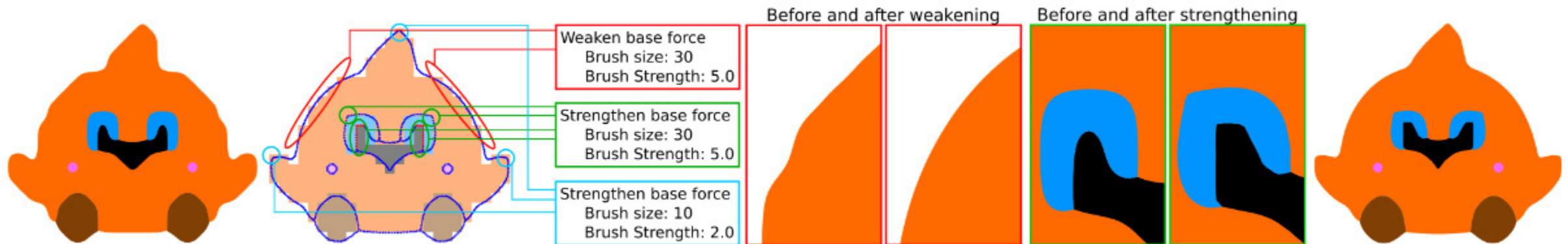
Method – Spring simulation User interaction

Simple mode



Sharp edges can be obtained

Advanced mode



Method – Output optimization

Creation of the curve network (V, E)

Minimize the following bezier curve

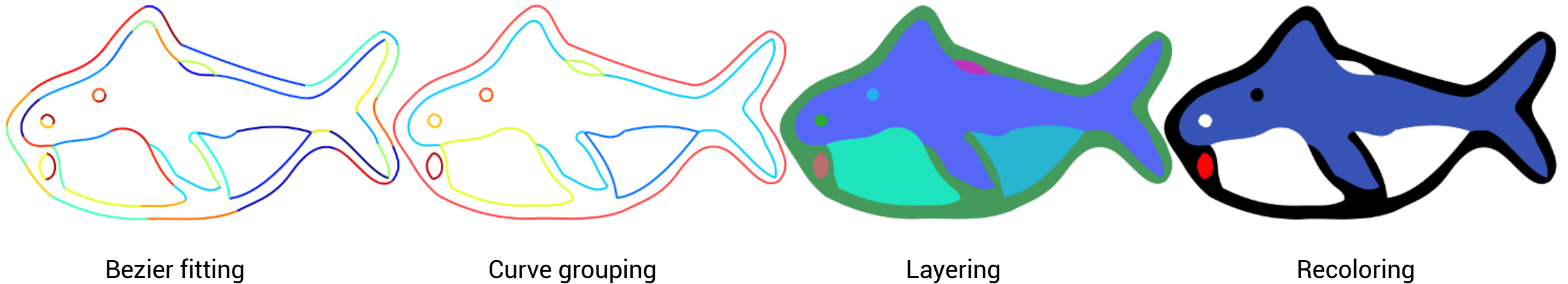
$$\varepsilon(e) = \sum_{p \in S^e} \| B^e(t_p) - p \|_2^2$$

Method – Output optimization

Creation of the curve network (V, E)

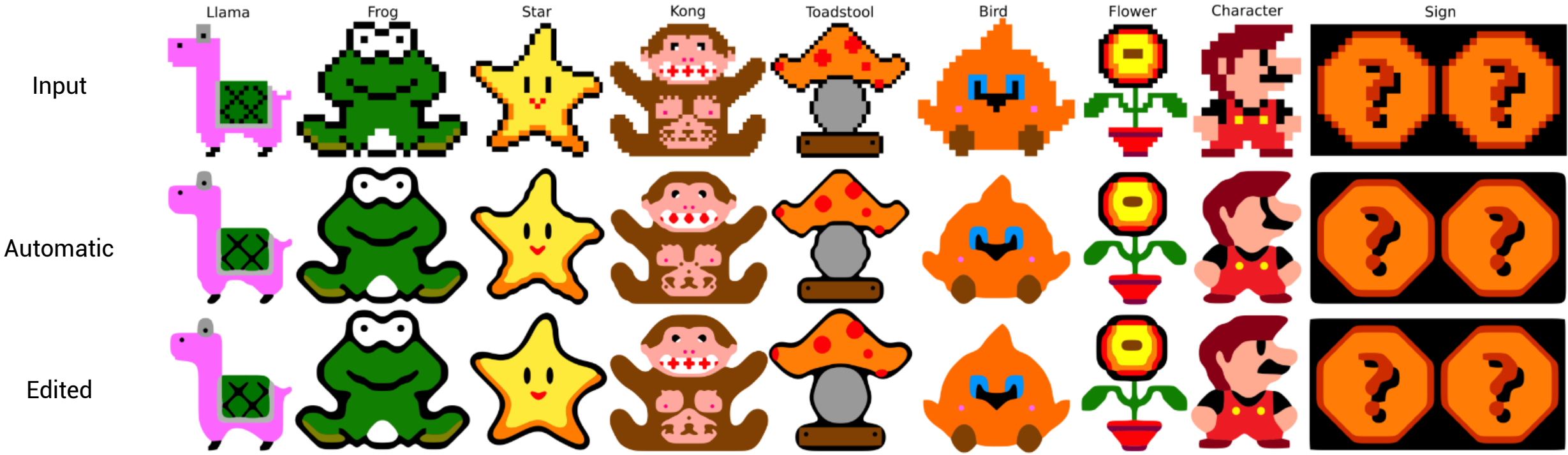
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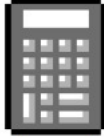
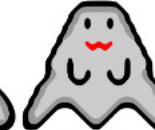
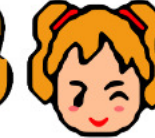


Results

Video



Results - Comparison

						 Editing
						
						
						 Disambiguation
						
						
						
						
Input pixel art	DPA [KL11]	InkScape [Ink]	PolyFit [DSG*20]	Ours (Automatic)	Ours (Interactive)	