Digital Image

(B4M33DZO, Summer 2024)

Lecture 12:

Image Segmentation 2

https://cw.fel.cvut.cz/wiki/courses/b4m33dzo/start

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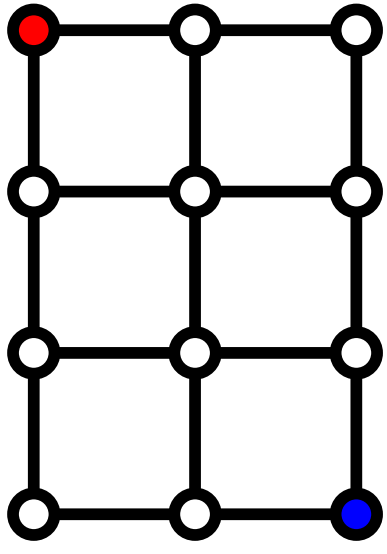
Extensions

Find an optimal labelling x^* such that:

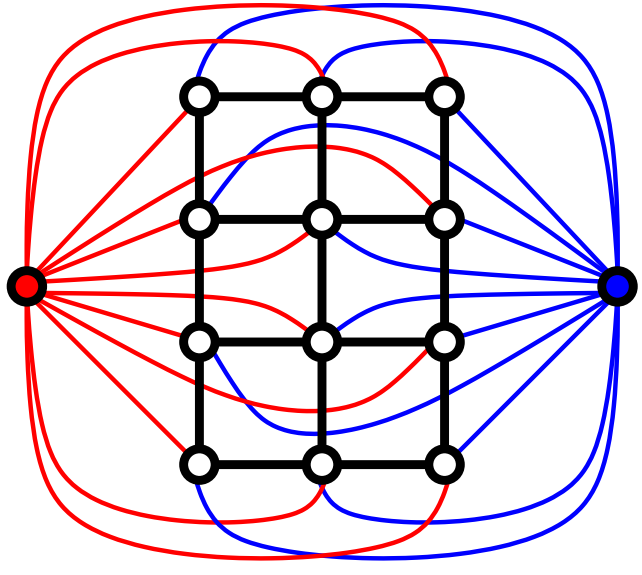
$$x^* = \arg\min_x \sum_{\{p,q\}\in\mathcal{N}} w_{pq} \left|x_p - x_q\right|^{\alpha} \quad \textbf{subject to: } x_s = 0 \ \wedge \ x_t = 1$$

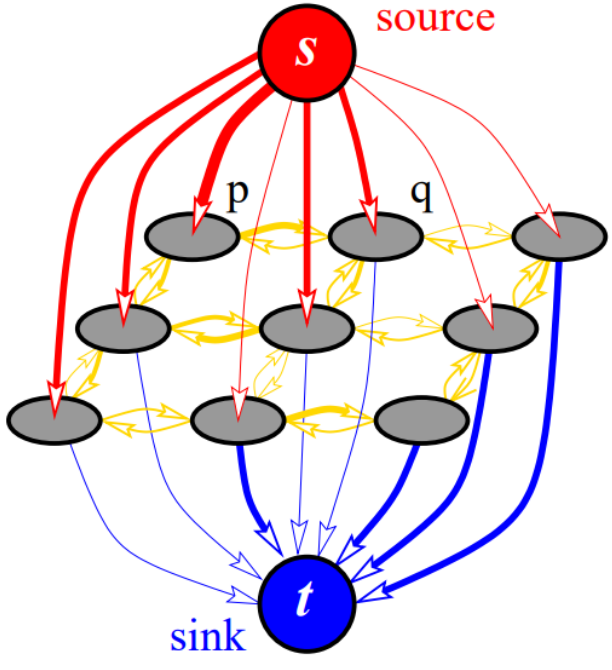


Extensions

Find an optimal labelling x^* such that:

$$x^* = \arg\min_x \sum_{\{p,q\}\in\mathcal{N}} w_{pq} \left|x_p - x_q\right|^{\alpha} + \sum_{p\in\mathcal{P}} w_{ps} x_p^{\alpha} + \sum_{p\in\mathcal{P}} w_{pt} \left|1 - x_p\right|^{\alpha}$$



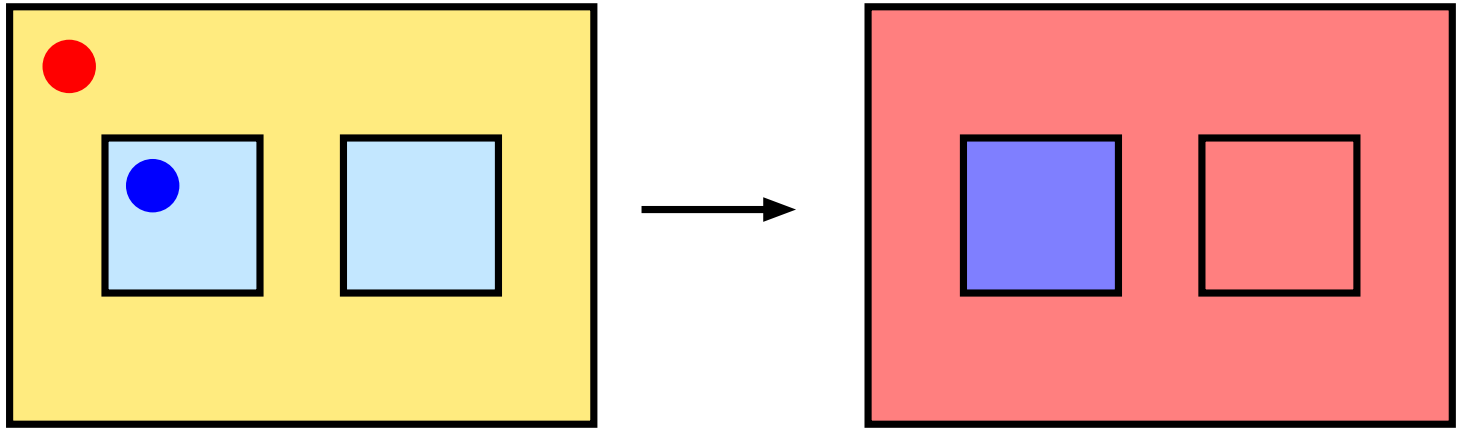


Extensions

Additional prior (color similarity):

weight	$\mathcal{S}$	$\mathcal{T}$	w/o scribble
w_{ps}	K	0	0
w_{pt}	0	K	0

$$K = 1 + \max_{p \in \mathcal{P}} \sum_{\{p,q\} \in \mathcal{N}} w_{pq}$$

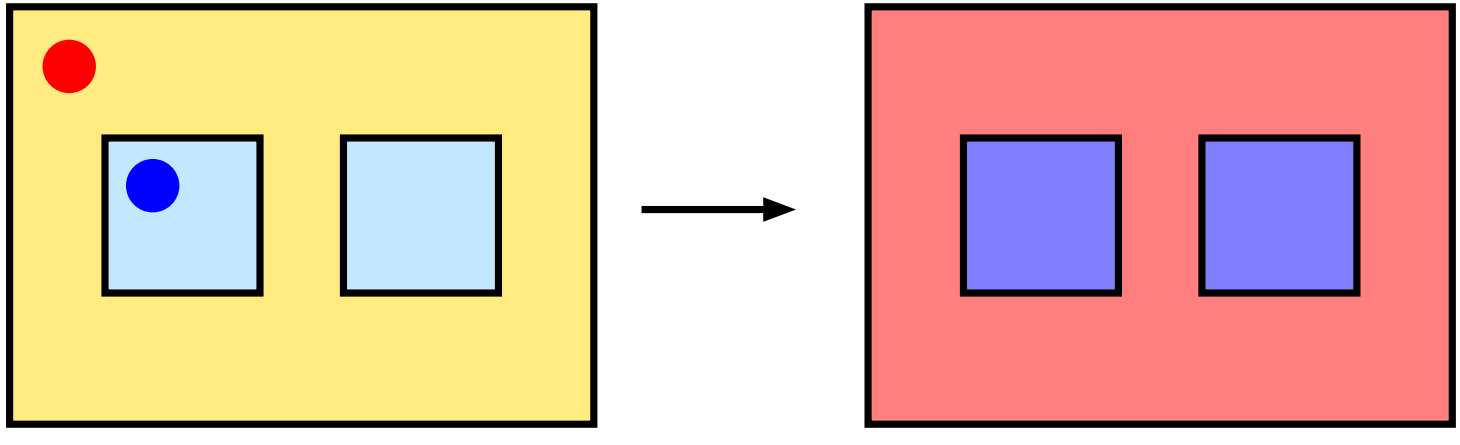


Extensions

Additional prior (color similarity):

weight	$\mathcal{S}$	$\mathcal{T}$	w/o scribble
w_{ps}	K	0	$-\ln \Pr(C_p \vert \mathcal{S})$
w_{pt}	0	K	$-\ln \Pr(C_p \vert \mathcal{T})$

$$K = 1 + \max_{p \in \mathcal{P}} \sum_{\{p,q\} \in \mathcal{N}} w_{pq}$$

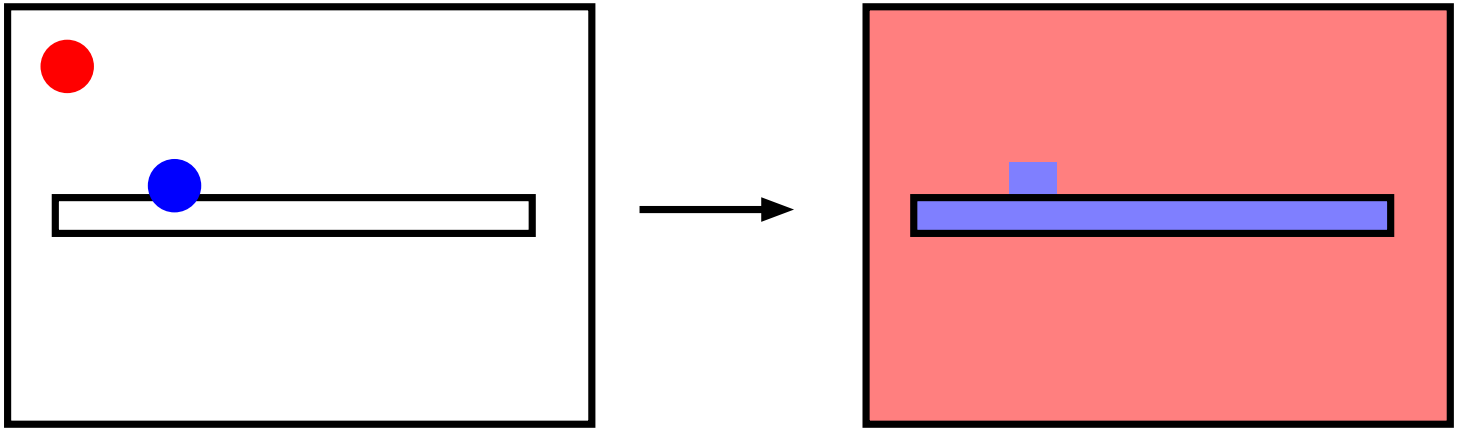


Extensions

Additional prior (soft scribbles):

weight	$\mathcal{S}$	$\mathcal{T}$
w_{ps}	λK	0
w_{pt}	0	λK

$$\lambda = 1$$

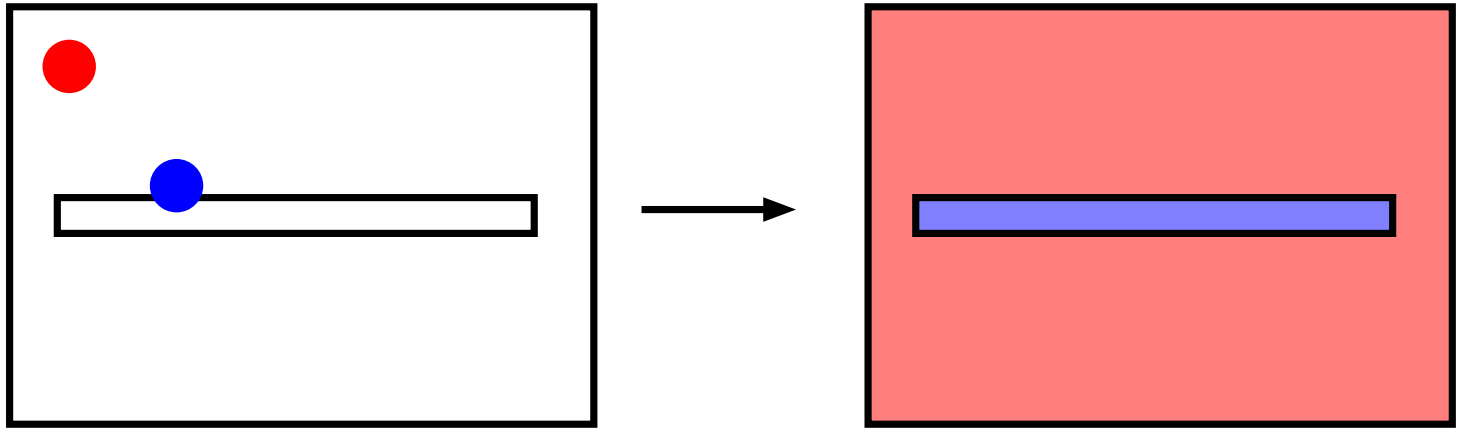


Extensions

Additional prior (soft scribbles):

weight	$\mathcal{S}$	$\mathcal{T}$
w_{ps}	λK	0
w_{pt}	0	λK

$$\lambda < \mathrm{perim}(\mathcal{T})/\mathrm{area}(\mathcal{T}) \approx 0.05$$

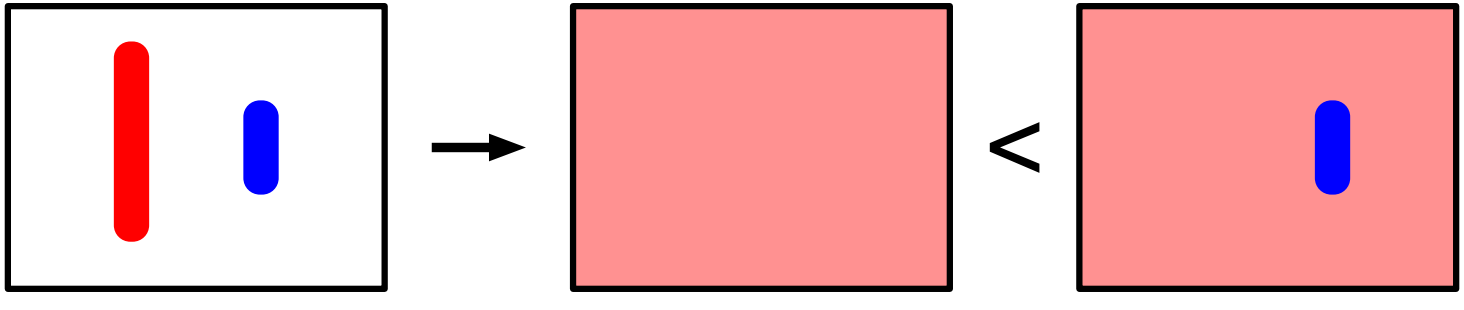


Extensions

Additional prior (soft scribbles):

weight	$\mathcal{S}$	$\mathcal{T}$
w_{ps}	λK	0
w_{pt}	0	λK

$$\sum_{\{p,q\}\in\mathcal{N}} w_{pq}\,|x_p - x_q|^{\alpha} \quad + \quad \sum_{p\in\mathcal{P}} w_{ps} x_p^{\alpha} \quad + \quad \sum_{p\in\mathcal{P}} w_{pt}|1 - x_p|^{\alpha}$$

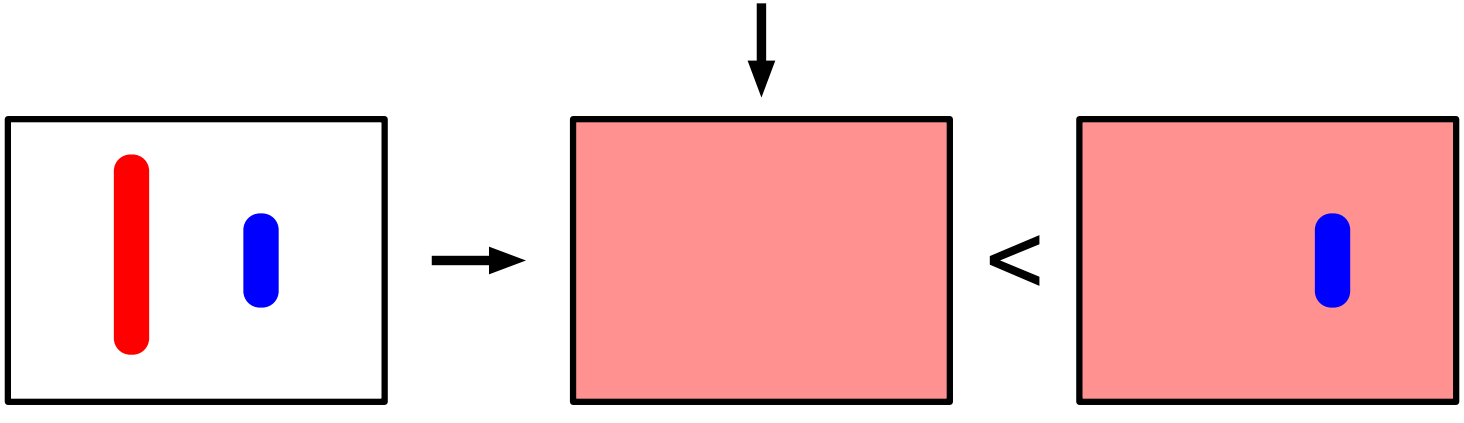


Extensions

Additional prior (soft scribbles):

weight	$\mathcal{S}$	$\mathcal{T}$
w_{ps}	λK	0
w_{pt}	0	λK

$$0 \quad + \quad 0 \quad + \quad \sum_{p \in \mathcal{T}} \lambda K$$

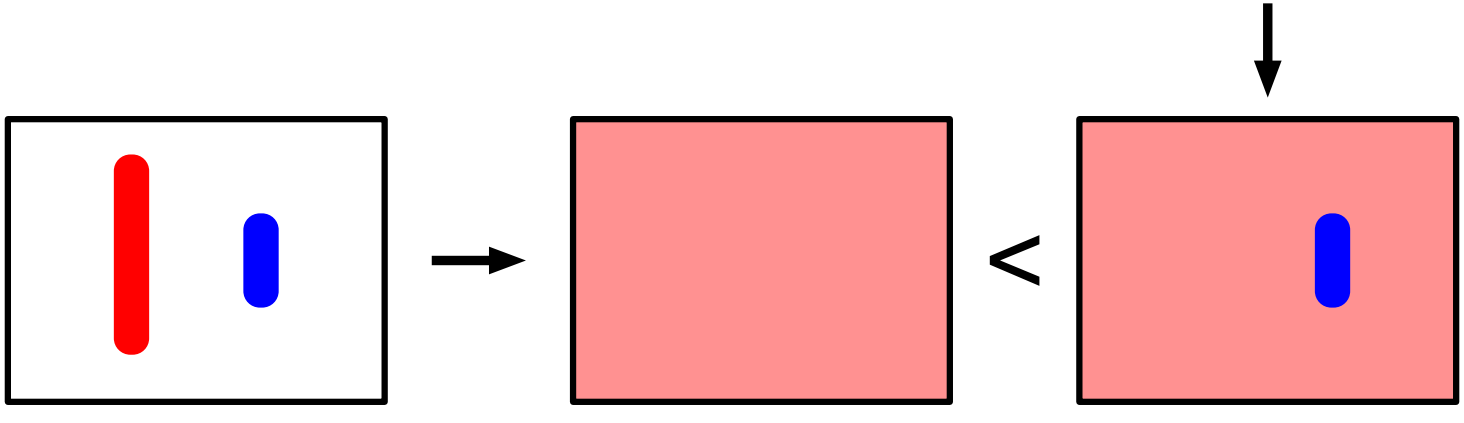


Extensions

Additional prior (soft scribbles):

weight	$\mathcal{S}$	$\mathcal{T}$
w_{ps}	λK	0
w_{pt}	0	λK

$$\sum_{\{p,q\}\in\partial\mathcal{T}} K \quad + \quad 0 \quad + \quad 0$$



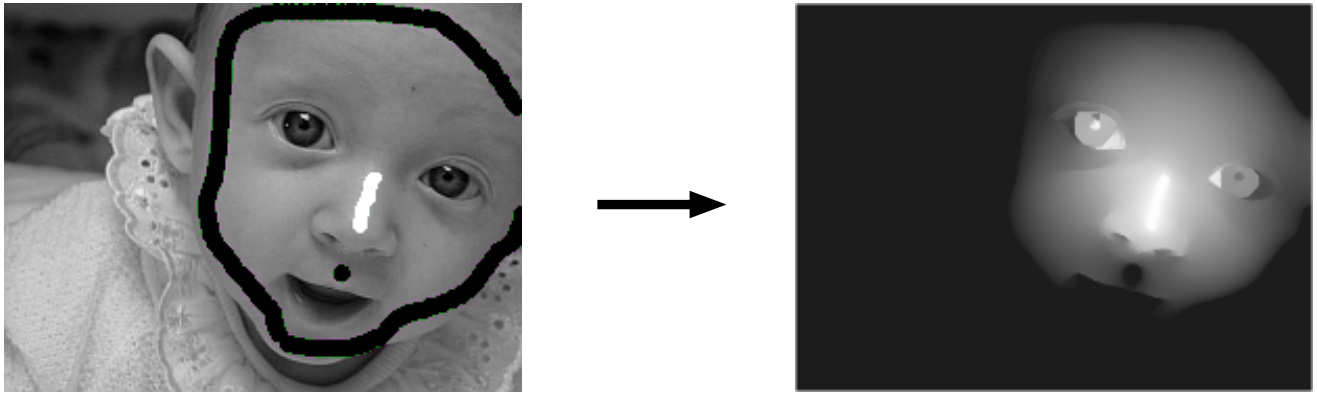
Extensions

Adding depth:

Find depth map d^* such that:

$$d^* = \arg\min_d \sum_{\{p,q\}\in\mathcal{N}} w_{pq} \left(d_p - d_q\right)^2$$

subject to constraints: $d_i = D_i$



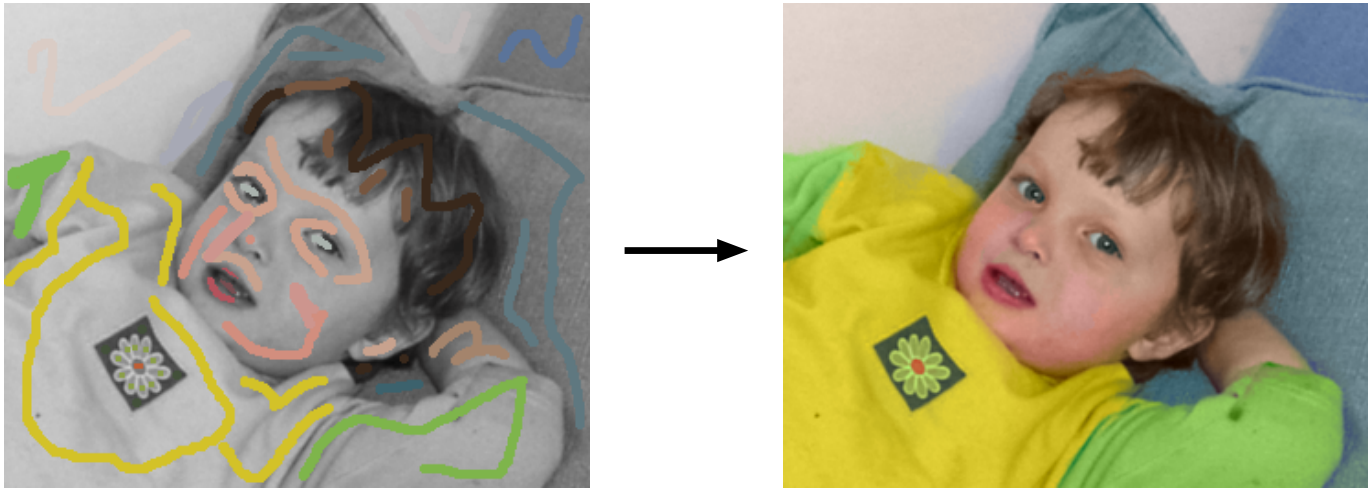
Extensions

Colorization:

Find color components of YUV model $[u, v]^*$ such that:

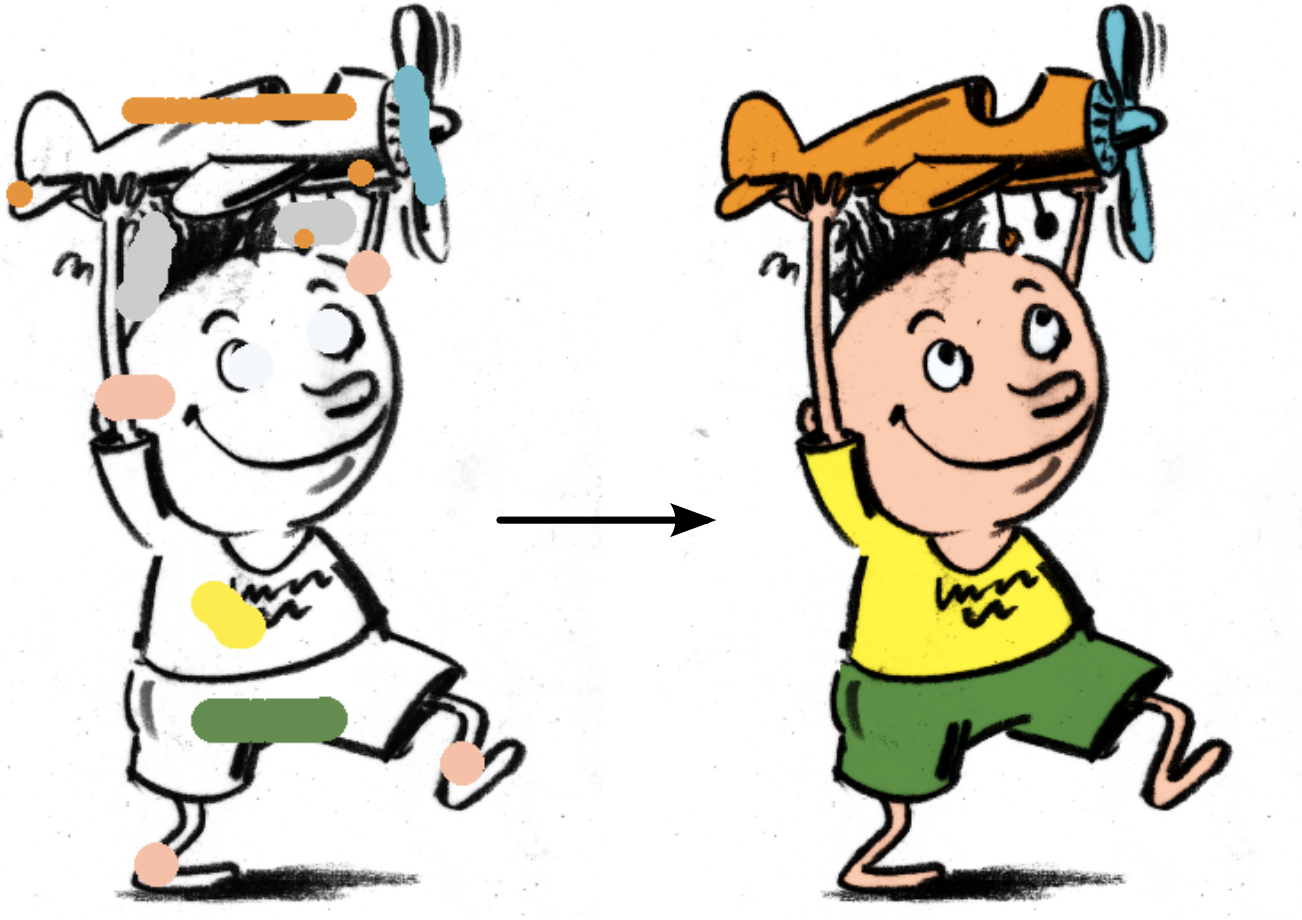
$$[u, v]^* = \arg\min_{[u,v]} \sum_{\{p,q\} \in \mathcal{N}} w_{pq} \left([u, v]_p - [u, v]_q \right)^2$$

subject to constraints: $u_i = U_i$ **and** $v_i = V_i$



Extensions

Painting:



Extensions

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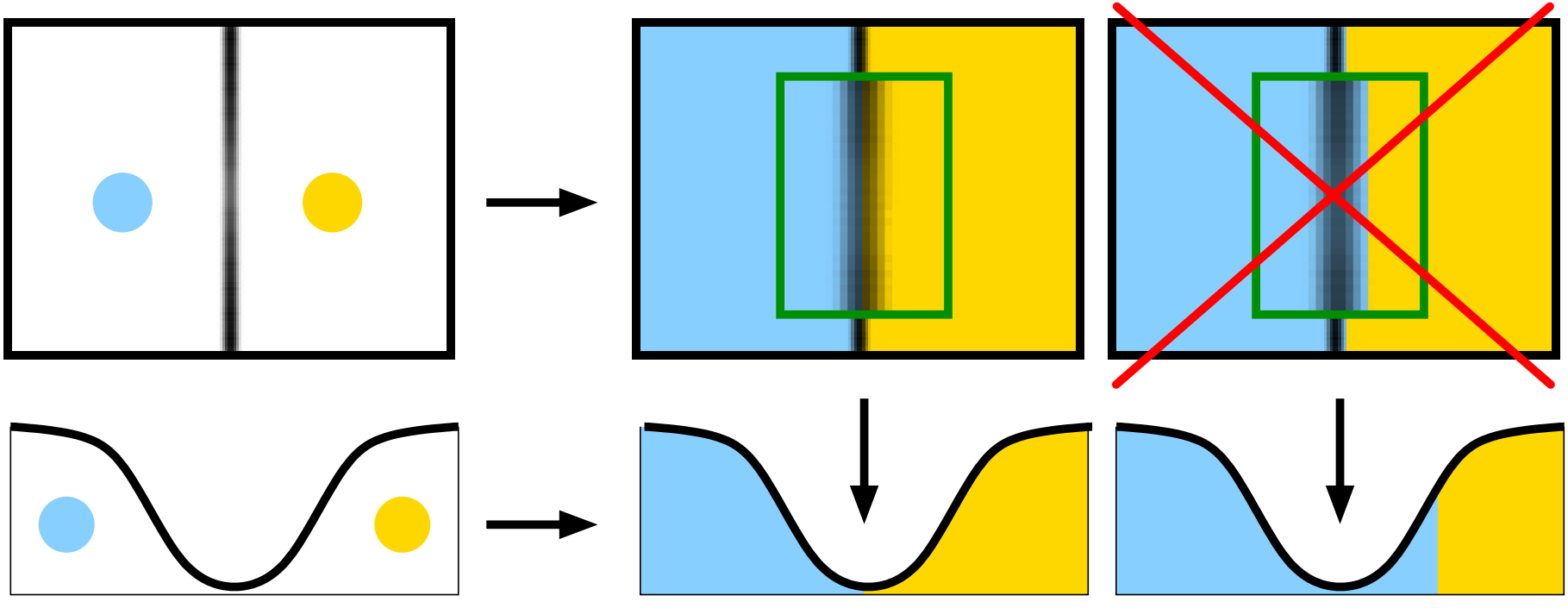
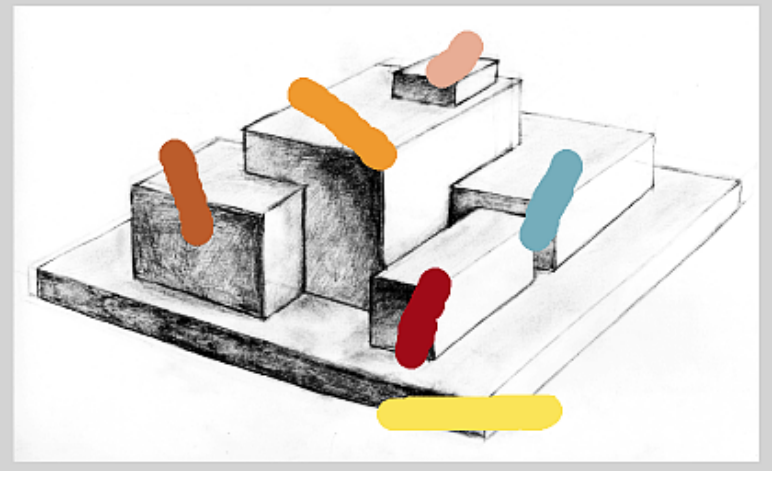


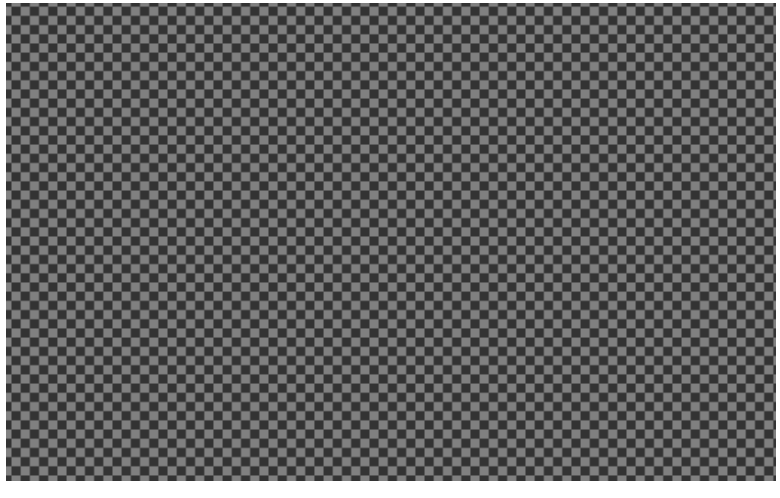
$$w_{pq} = \qquad 1 + K' \min(I_p, I_q)^\gamma \qquad \exp\left(-\frac{1}{\sigma^2}(I_p - I_q)^2\right)$$

Extensions

Multiple segments:

1. **Remove regions containing only one label.**
2. **Mark one label as s and other as t.**
3. **Solve binary s-t segmentation problem.**
4. **Remove pixels labelled with s.**
5. **When there are unlabelled pixels goto 1.**





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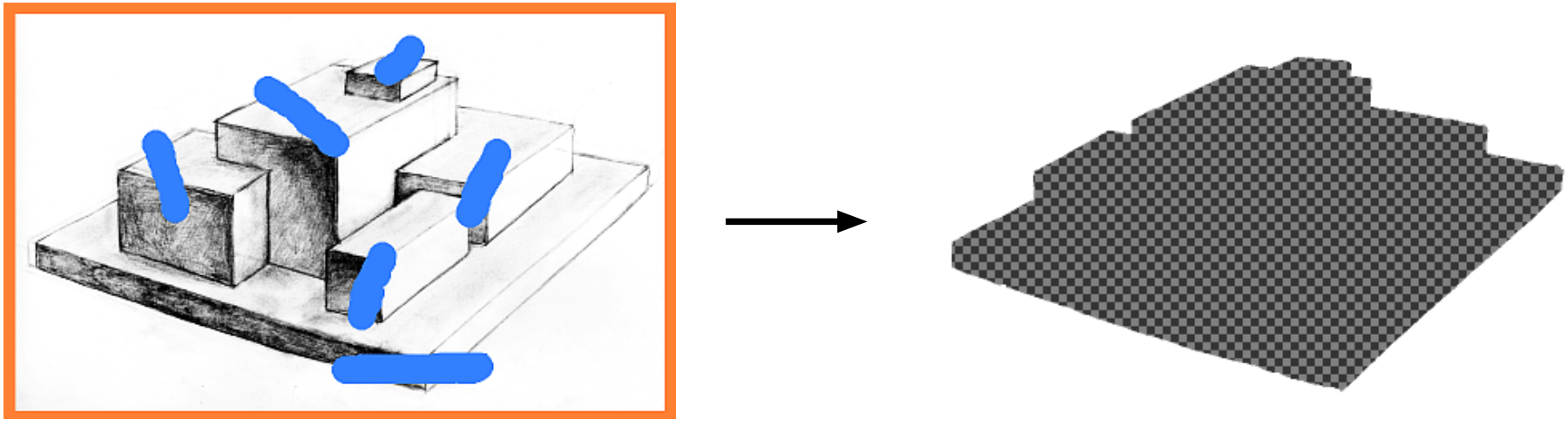

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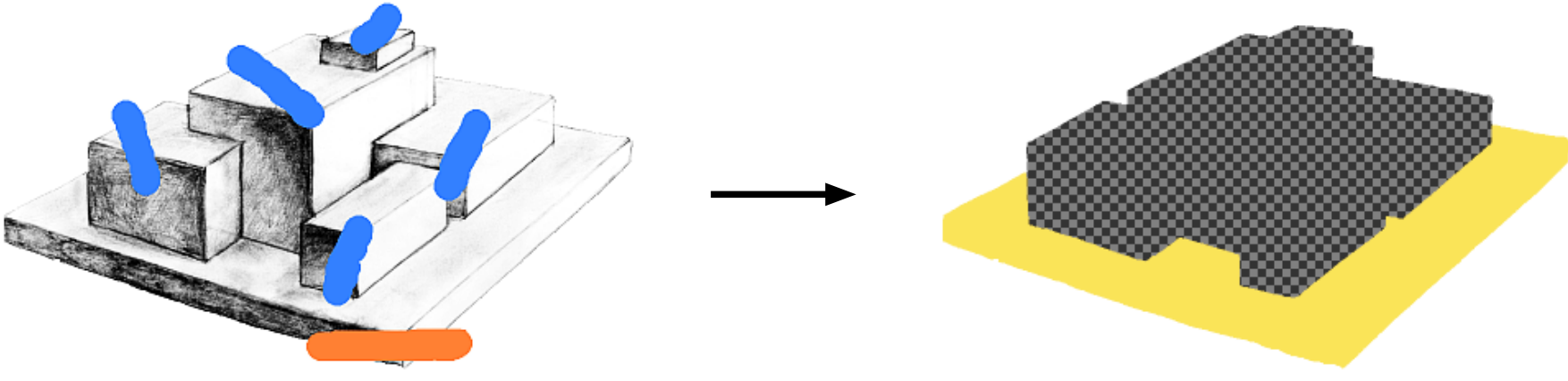

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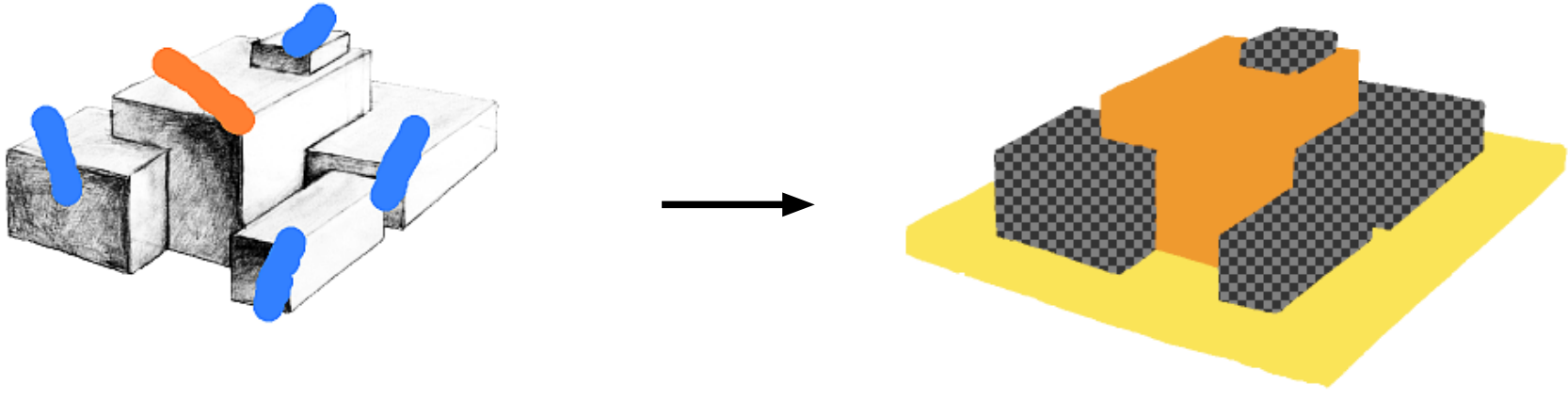

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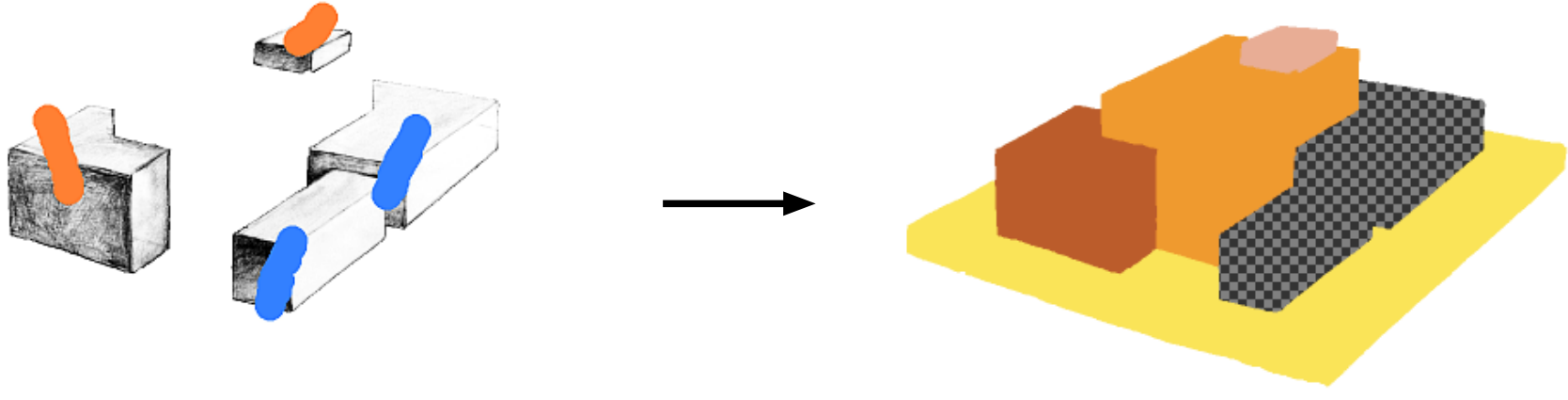

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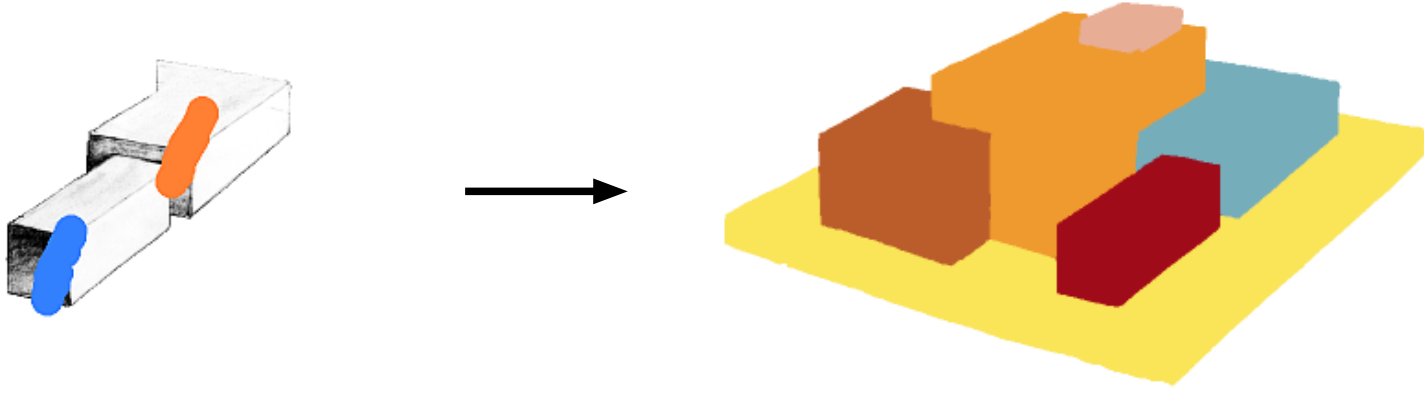

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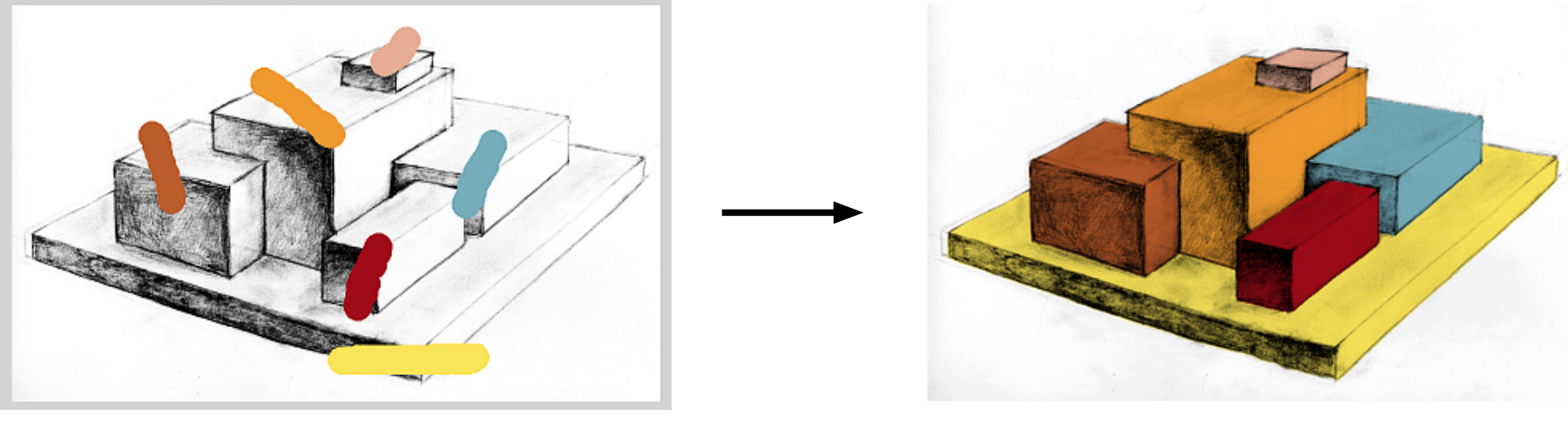

Extensions

Interactive painting: