$$\mathcal{L} = \sum_{p \in \mathcal{P}} \ell_p$$

a

$$\mathcal{L}_{\text{scribble}} = \sum_{p \in \mathcal{P}} w_p \, \ell_p \quad \text{where,} \quad w_p = \begin{cases} 1, & \text{if } \; p \in \mathcal{S} \\ 0, & \text{else.} \end{cases}$$

a

$$\boldsymbol{M}^* = \arg\max_{\boldsymbol{M}} \, \boldsymbol{p}(\boldsymbol{M})\boldsymbol{p}(\boldsymbol{I}|\boldsymbol{M})$$

$$\begin{aligned} E(\boldsymbol{M}) &= -\log(\boldsymbol{p}(\boldsymbol{I}, \boldsymbol{M})) = -\log(\boldsymbol{p}(\boldsymbol{I}|\boldsymbol{M})) - \log(\boldsymbol{p}(\boldsymbol{M})) \\ &= E_d(\boldsymbol{I}, \boldsymbol{M}) + E_r(\boldsymbol{M}) \\ &= \langle \mathcal{C}(\boldsymbol{P}), \boldsymbol{M} \rangle + \lambda \, TV(\boldsymbol{M}) + \iota_{[0,1]}(\boldsymbol{M}) \end{aligned}$$

$$\mathcal{C}(\widehat{\boldsymbol{P}}(x_p)) = \begin{cases} 0, & \text{if } x_p \in \mathcal{S} \\ -\log \frac{\widehat{\boldsymbol{P}}(x_p)}{1-\widehat{\boldsymbol{P}}(x_p)}, & \text{else} \end{cases}$$

$$E(\boldsymbol{M}) = \langle \mathcal{C}(\boldsymbol{P}), \boldsymbol{M} \rangle + \lambda \, TV(\boldsymbol{M}) + \iota_{[0,1]}(\boldsymbol{M}) + \iota_{\text{FG}}(\boldsymbol{M}) + \iota_{\text{BG}}(\boldsymbol{M})$$