

Opening and closing

- Goal: smoothing without size change

- Open filter

$$\textit{open}(f, W) = \textit{dilate}(\textit{erode}(f, W), W)$$

- Close filter

$$\textit{close}(f, W) = \textit{erode}(\textit{dilate}(f, W), W)$$

- Open filter and close filter are biased

- Open filter removes small 1-regions
- Close filter removes small 0-regions
- Bias is often desired for enhancement or detection!

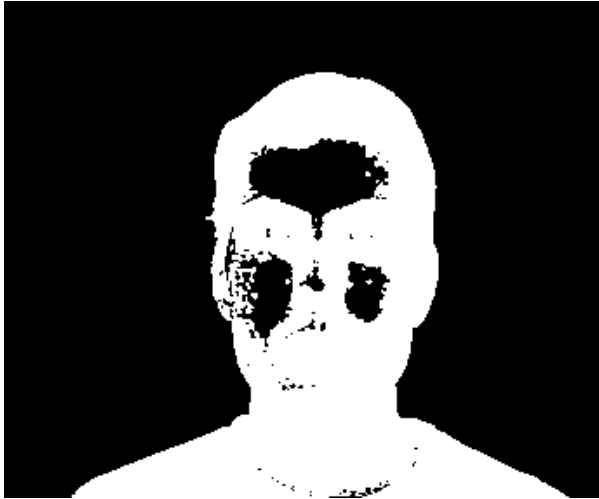
- Unbiased size-preserving smoothers

$$\textit{close} - \textit{open}(f, W) = \textit{close}(\textit{open}(f, W), W)$$

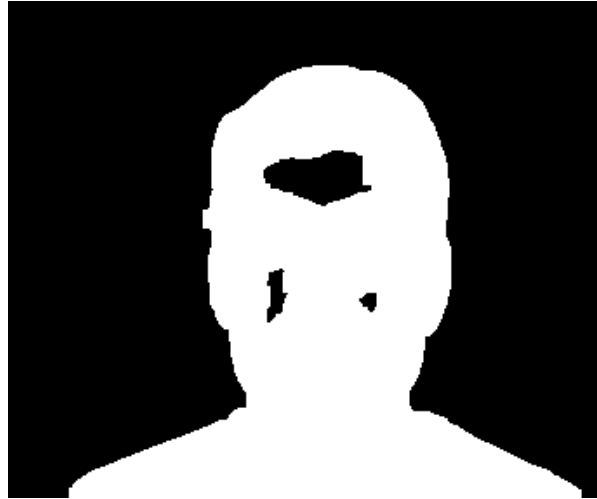
$$\textit{open} - \textit{close}(f, W) = \textit{open}(\textit{close}(f, W), W)$$

- *close-open* and *open-close* are duals, but not inverses of each other.

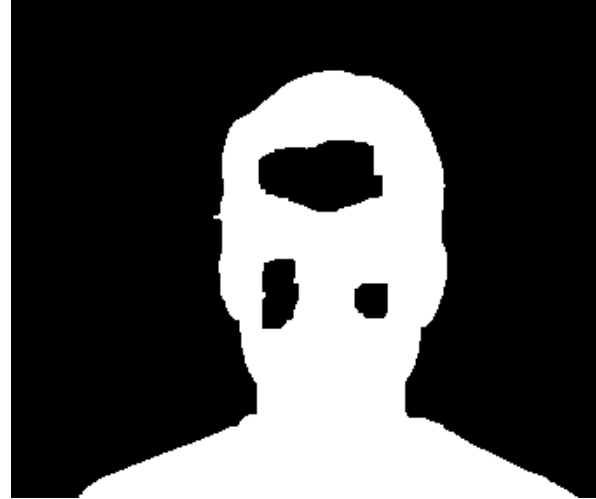
Small hole removal by closing



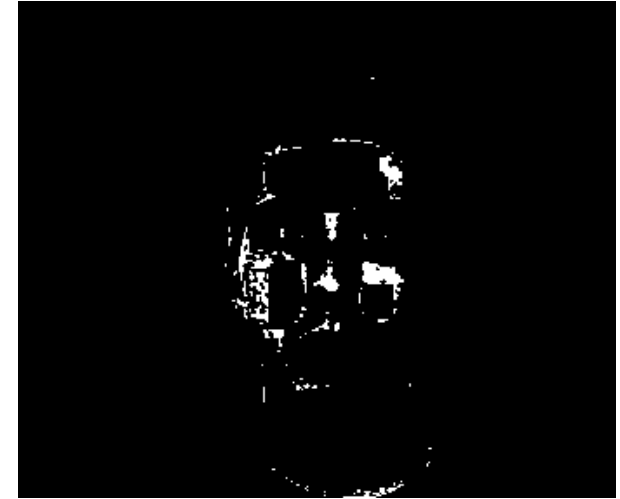
Original binary mask



Dilation
10x10



Closing 10x10



Difference to original mask

