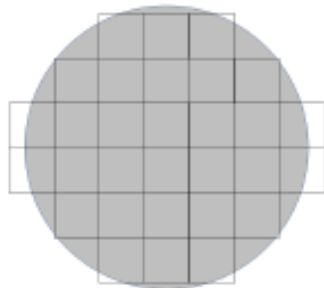


Goal: Segment real defects in SEM images by CNN training with no manual labeling.

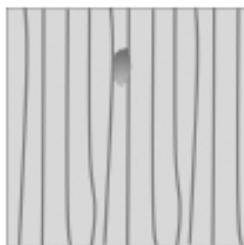
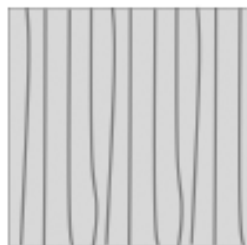
Silicon Wafer



Scanning Electron Microscopy

Clean Background

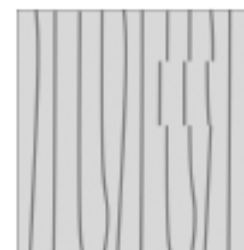
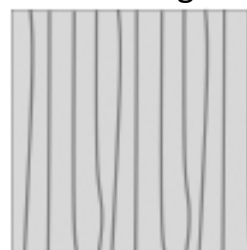
True Defect



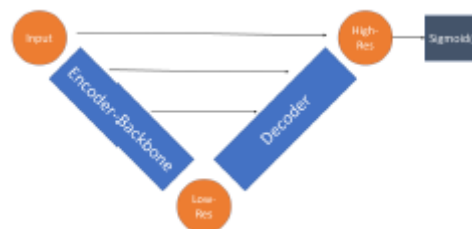
Copy-Paste Augmentation

Clean Background

Simulated Defect



Architecture



Supervised Loss

$$WBCE(p, y) = \frac{1}{N} \sum_{i=1}^N w_i y_i \log p_i$$

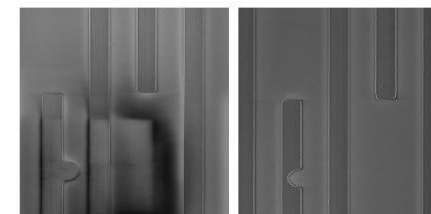
Contrastive Loss

$$CLR(x, A) = -\frac{1}{N} \sum_{i=1}^N \log \frac{\exp(\text{sim}(x_i, A(x_i))/\tau)}{\sum_j \exp(\text{sim}(x_i, A(x_j))/\tau)}$$

Consistency Loss

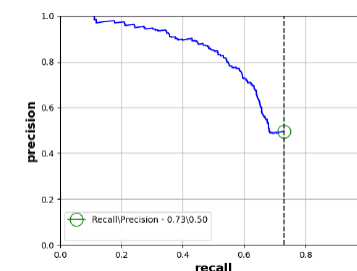
$$CL(p_1, p_2) = \sum_x p_1(x) \log(p_2(x)) + \sum_x p_2(x) \log(p_1(x))$$

Simulation SEM Images



Unsupervised Performance

Unsupervised Algorithm	F-Measure	Precision	Recall
D-CLR	0.65	0.65	0.64
W-BCE	0.62	0.7	0.55



Fully Supervised Performance

Algorithm	F-Measure	Precision	Recall
Teacher-Student-Ref	0.87	0.83	0.92
D-CLR-Ref	0.86	0.82	0.89
W-BCE-Ref	0.85	0.84	0.86
Teacher-Student	0.8	0.75	0.85
D-CLR	0.74	0.69	0.78
W-BCE	0.82	0.76	0.87
Classic-Ref	0.73	0.59	0.92