
ND path finder

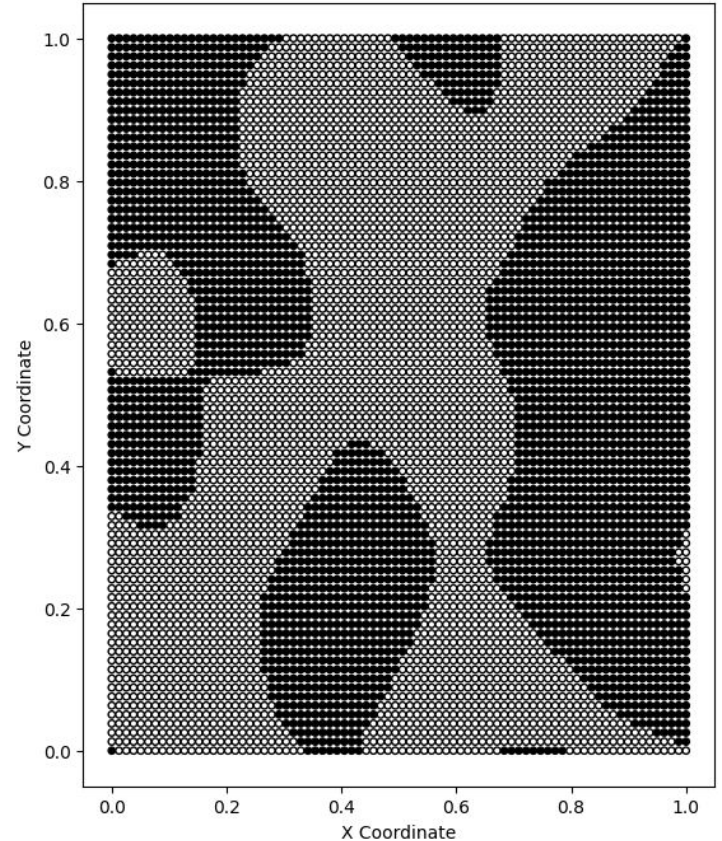
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Wu, Dilan Karaguler, Yangxiao Luo, Jingheng
Wang



The Erdos Institute

Intro

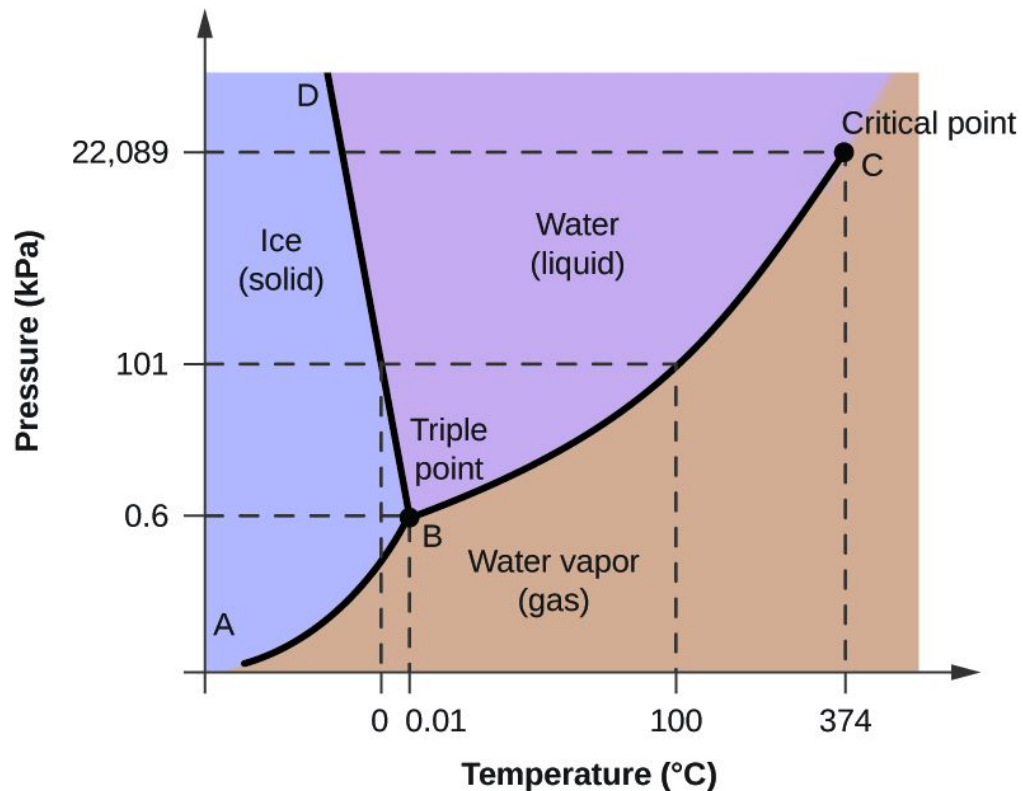
- If we want to find the optimal pathway in some N-dimensional space what key information do we need?
 - **Boundaries**
 - Curvature of paths
 - Dead-ends
- Dimensionality reduction techniques typically have a trade-off between
 - Distances
 - Angles
 - High dimensional structure



Use cases

This algorithm is designed to march through N-dimensional space it can be used for:

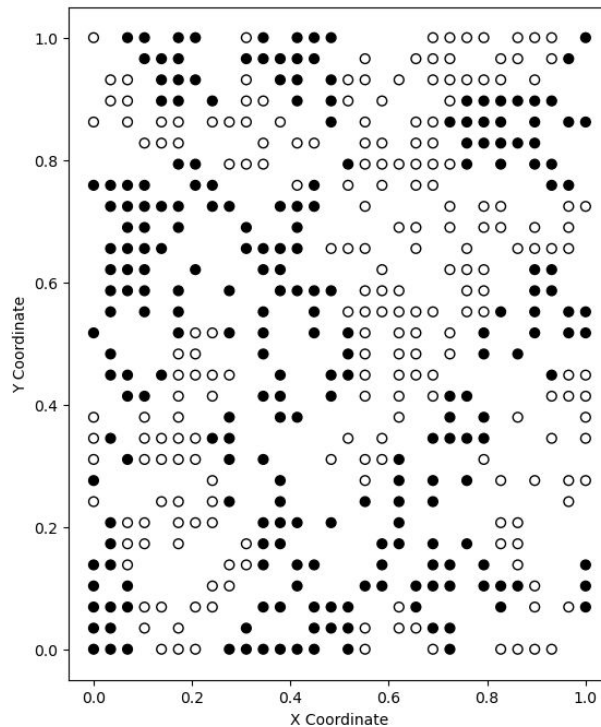
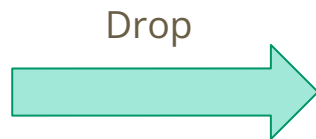
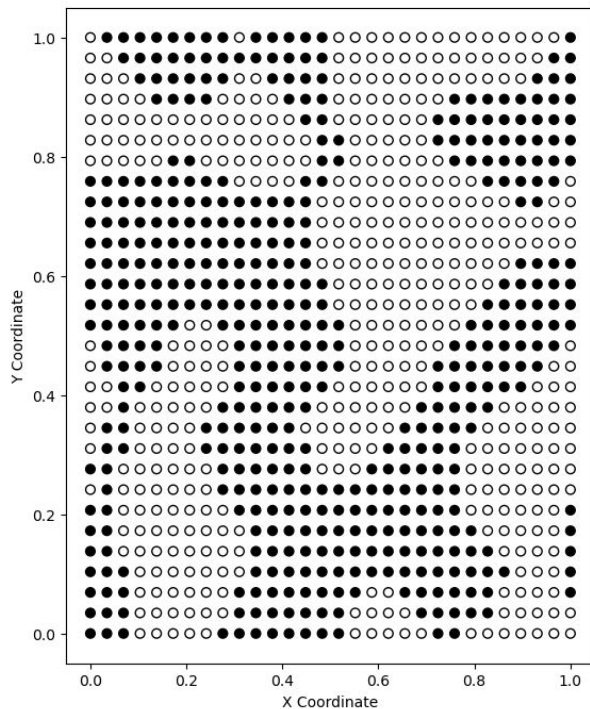
- Optimization/best path-finding algorithm
 - Nuclear fusion optimization
 - Engine performance optimization
- Phase diagrams exploration (2D example)
- What data could recreate some “physical” systems?



Phase diagram for water at different temperatures and pressures.

Source: OpenStax. (2019). Chemistry 2e. Retrieved from <https://openstax.org/details/books/chemistry-2e>

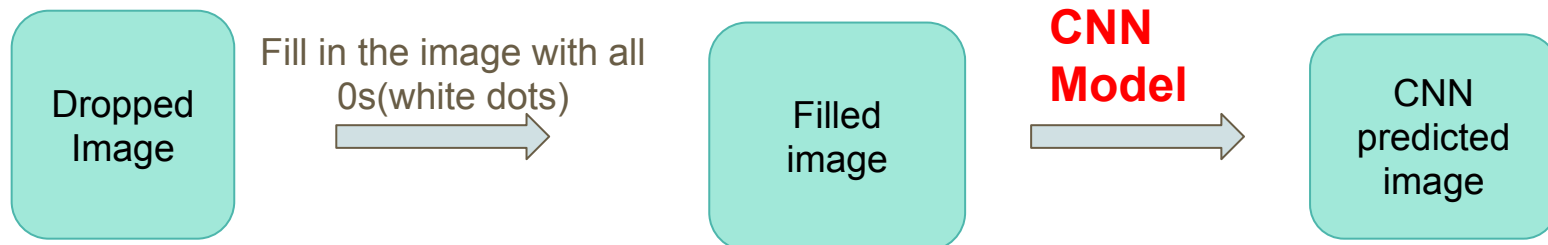
Data creation



- Use 2D-Perlin noise of resolution (30,30) with octaves 4

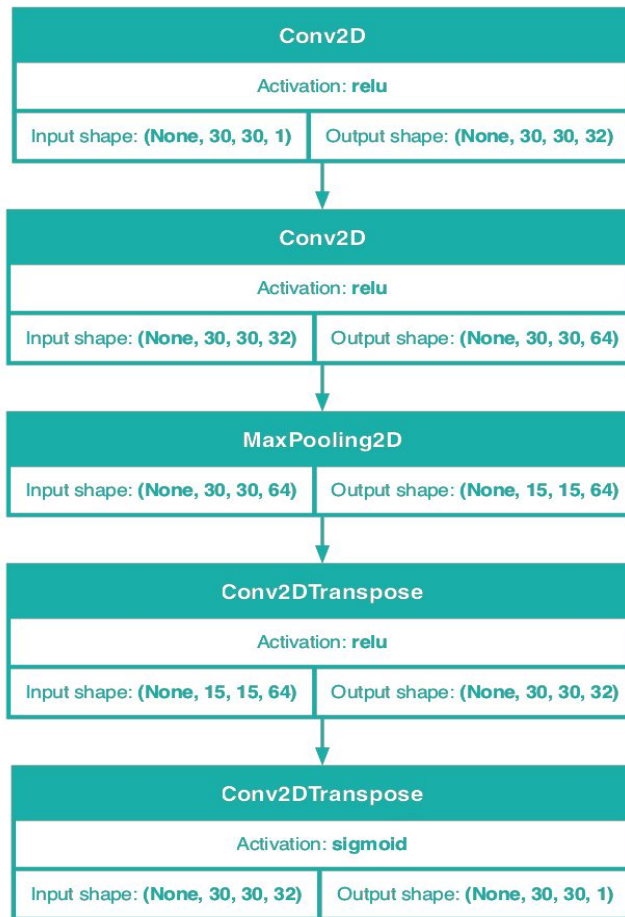
- Drop 50% of the data

CNN Model:



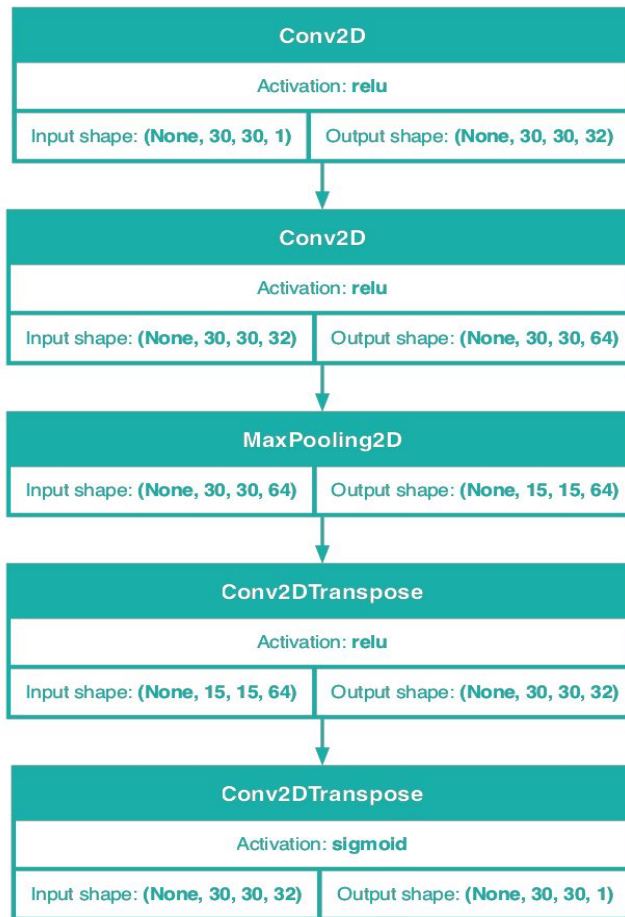
CNN Model

- Description of the layers
 - Two convolution layers, one MaxPooling layer, then two deconvolution layers.
 - We use Sigmoid function as our activation function in the last layer to get values between 0 and 1.



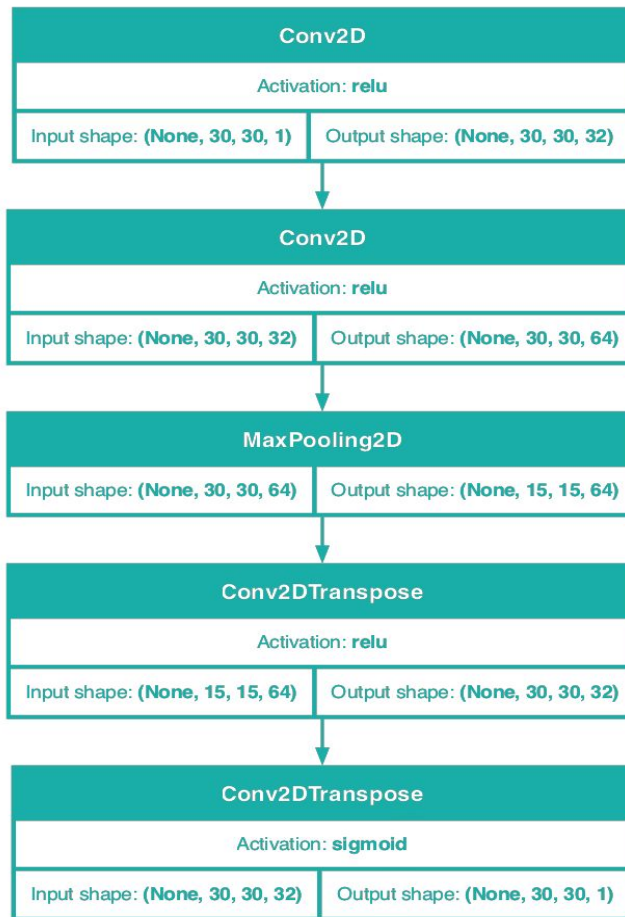
CNN Model

- Deconvolution layer:
 - Increase the dimension of the input
 - Make sure the output is of the same dimension as input
 - Set the stride=2

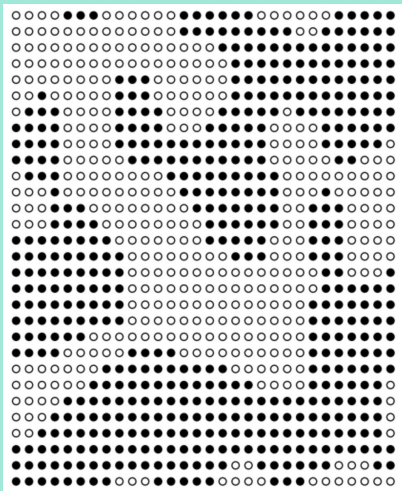


CNN Model

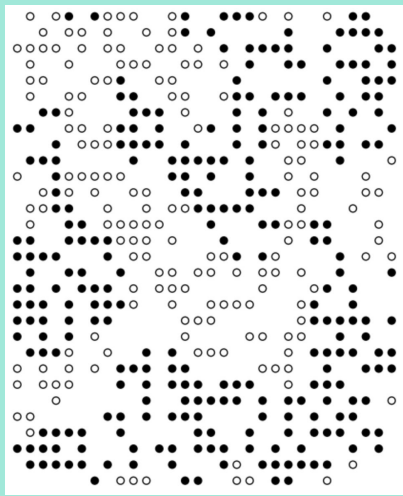
- Loss function: Weighted cross entropy
 - $\text{loss_function} = -a \cdot \log(1 - y_{\text{pred}}) - b \cdot \log(y_{\text{pred}})$
 - $a = \frac{\text{\#edge points}}{\text{\#total points}}$
 $b = 1 - a$



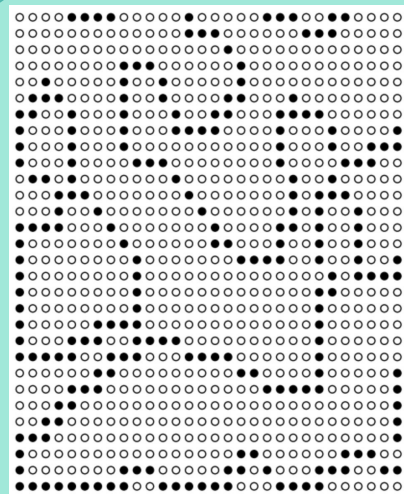
CNN Model result visualization



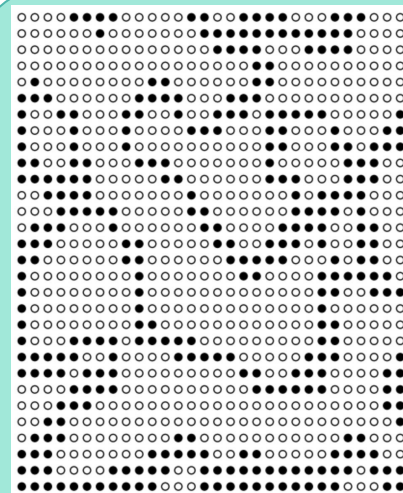
Original Image



Dropped Image



Real Edge

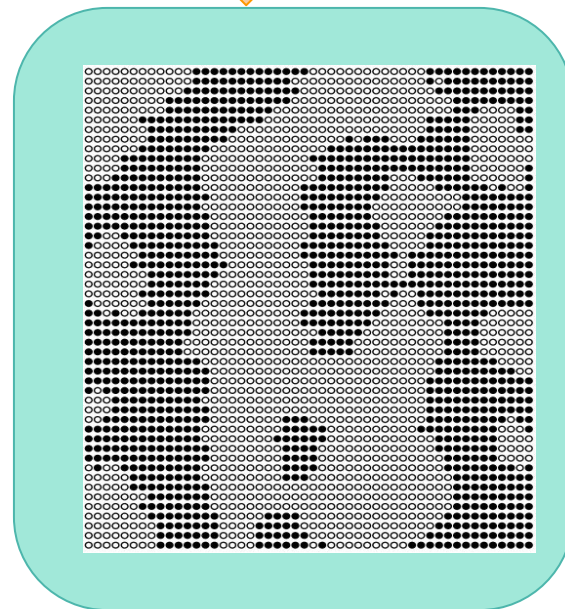
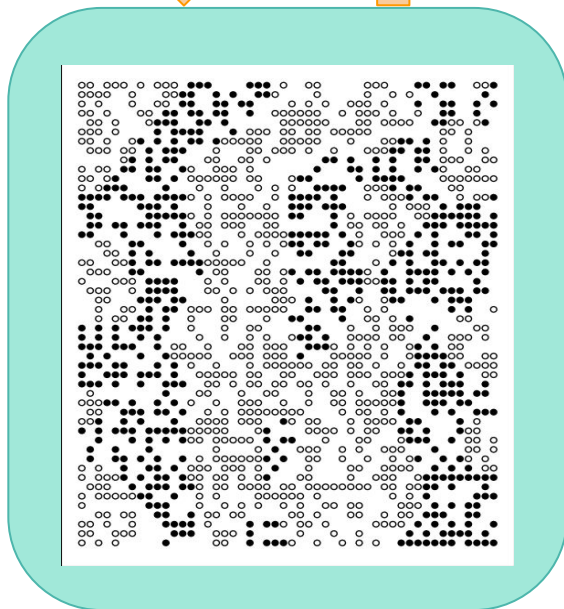
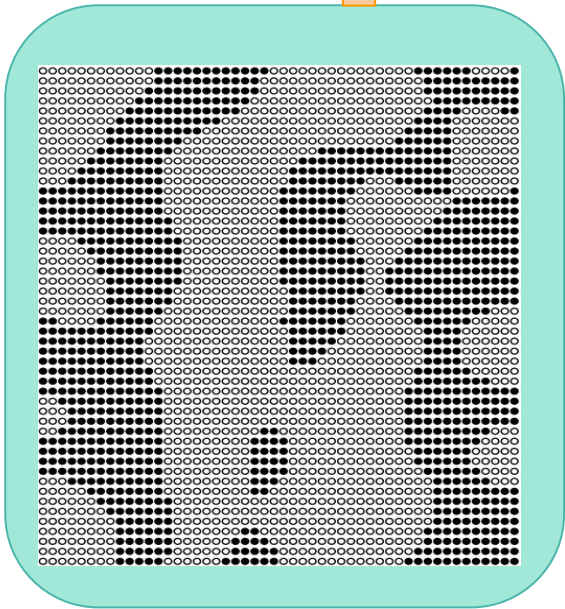


Predicted Edge

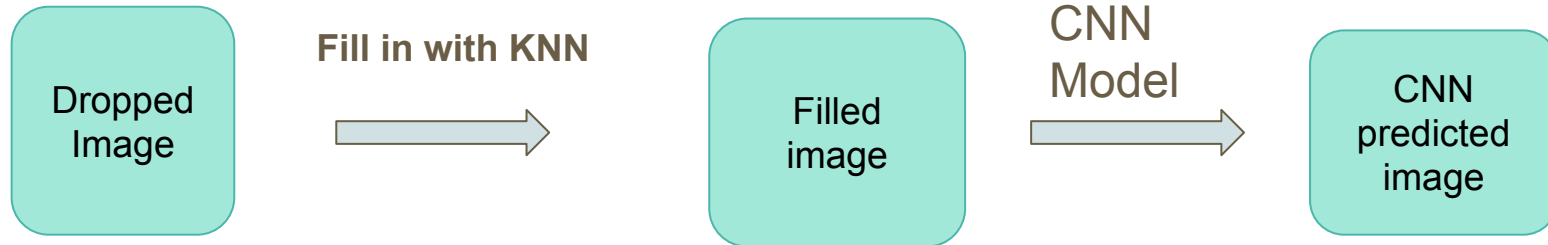
KNN filler

Drop information

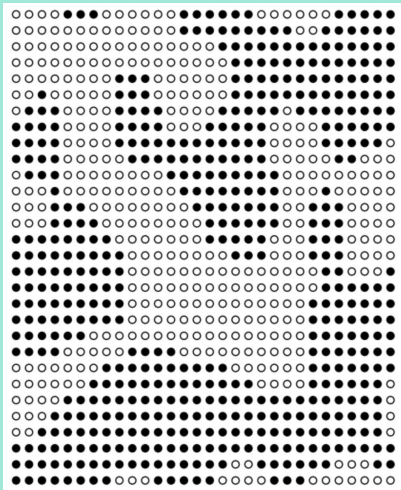
Fill in with KNN filler



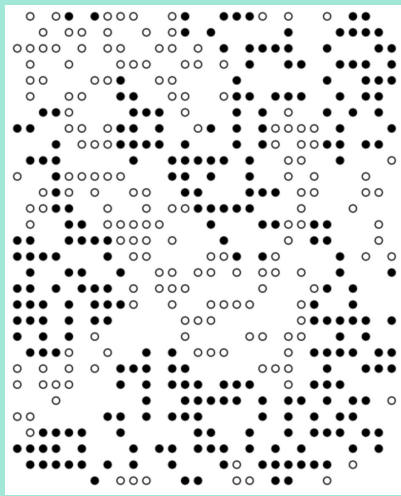
KNN-CNN Model:



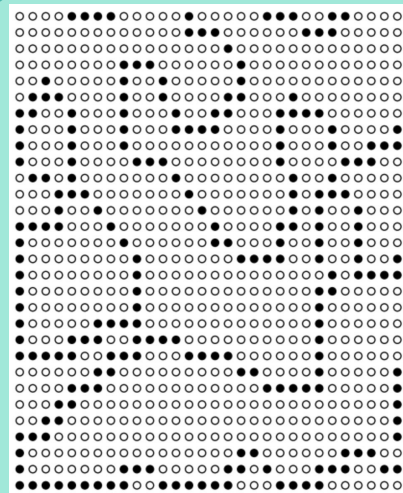
KNN-CNN Model result visualization



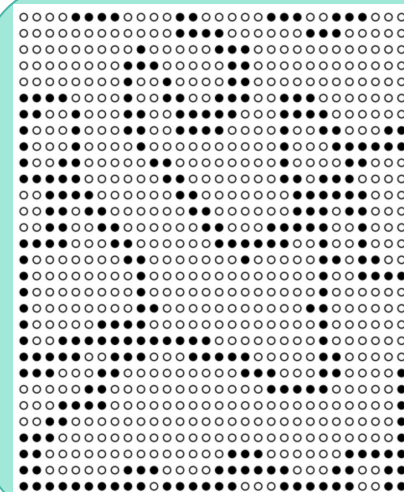
Original Image



Dropped Image

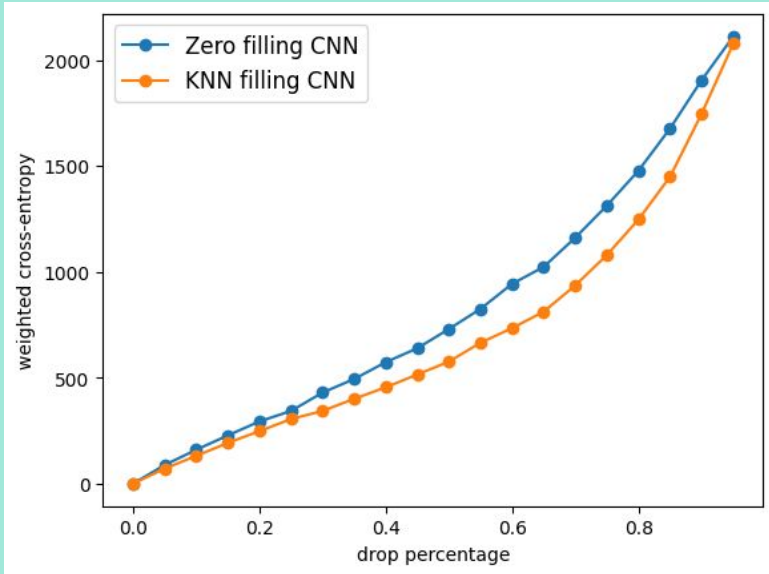


Real Edge

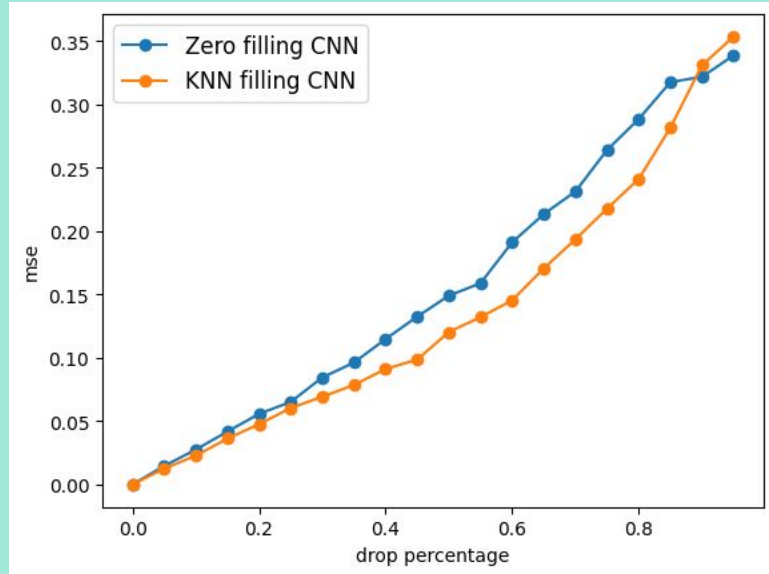


Predicted Edge

Comparing models



WCE



MSE

Future Work

- Improving boundary detection -> better path finding algorithm through the space
 - Initial exploration into Voronoi points for path finding
- Other boundary measurement methods:
 - Hausdorff distance - max distance between curves (sets)
 - Chamfer distance - average distance between curves
- Whether our model can generalize to higher dimensions, and if not what model(s) would be good alternatives