Mathematical Data Science HW9

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Problem 1

Solution. We would like to explain the distribution of fine dust using the 2DCA model. We define environmental influences such as wind and factories as random variables, and model how they participate in the spread of fine dust through programming. Wind moves dust in a given direction, and factories periodically emit dust from fixed locations. We can provide dust data at a specific point in time as initial input and then experiment to see if it shows the expected results over time. However, due to very limited variables, data, time, and insufficient skills, the results were significantly different from reality. We should have looked at the data first and planned the direction of the experiment.

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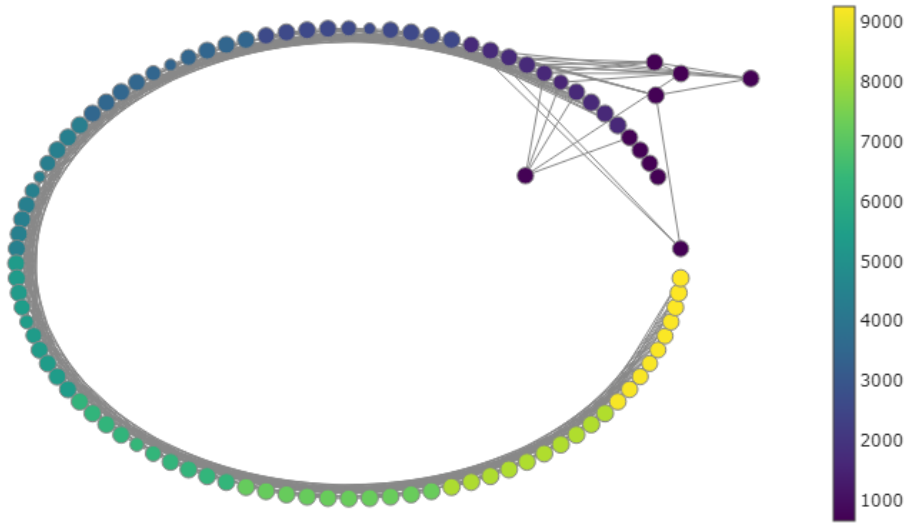
Problem 2

Solution. This is the mapper graph with my hand.

Also, this is the mapper graph with my eraser.



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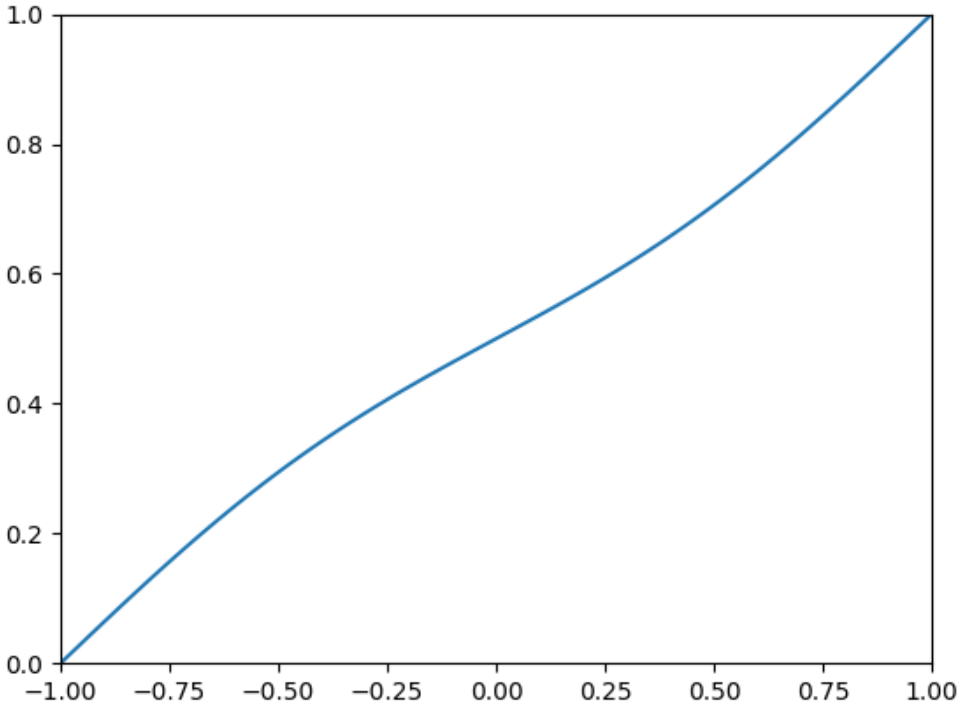
Problem 3

Solution. Consider it as a heat trasfer on a line. Since the boundary conditions are 0 and 1, we can guess that the solution will become a line connecting both ends finally. i.e. $\lim_{t\to\infty} u(x,t) = x$. Here is the numerical result.



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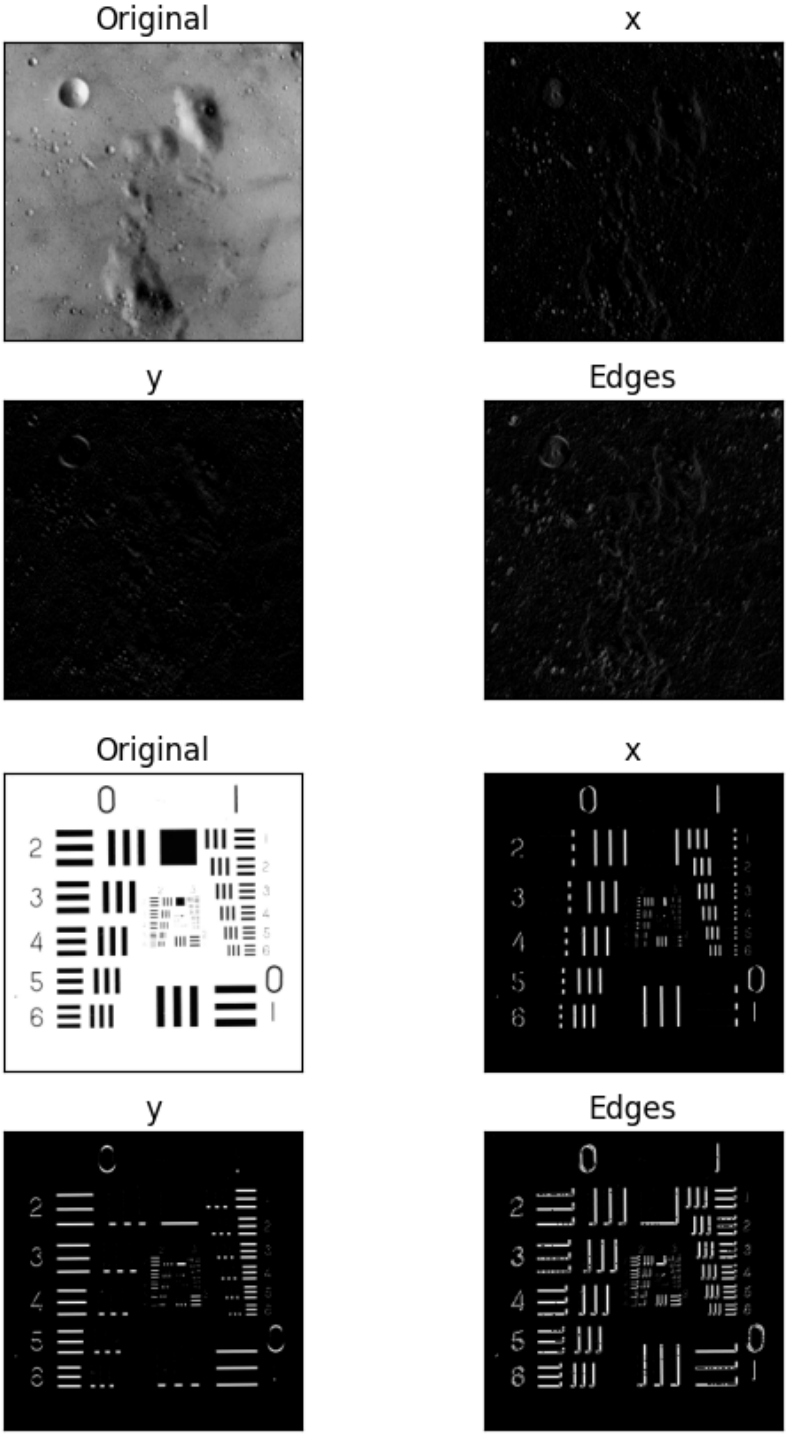
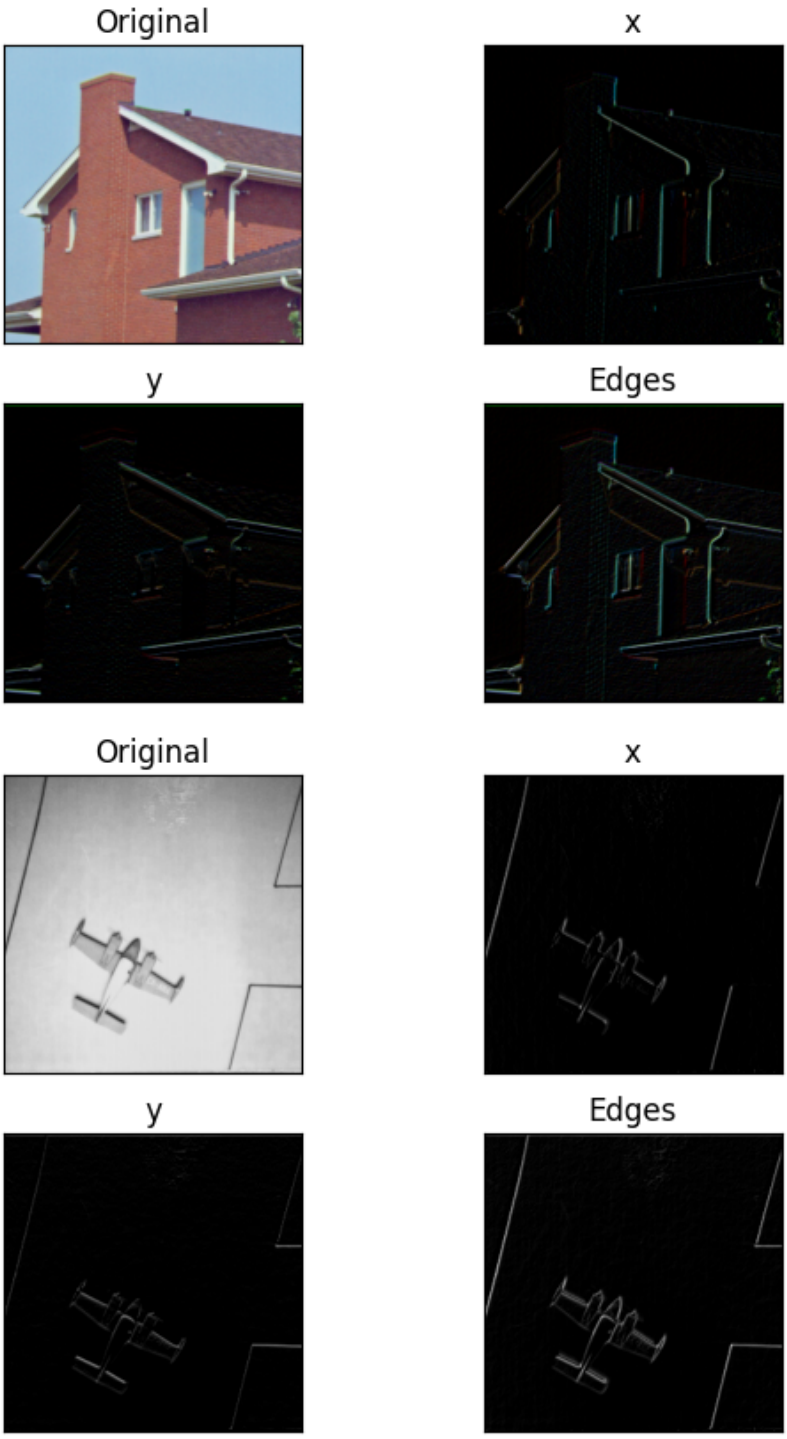
Problem 4

Solution. Here are results.





An idea to consider when trying to find the edge of an image is to claim that the edge is where the color intensity changes. This is quite reasonable, based on our perception. The most intuitive way to find areas where color intensity changes is to use differentiation. When calculating the first derivative along the x and y axes, the part where the derivative changes rapidly can be considered an edge.

We cannot define continuous differentiation in images due to computational limitations. Therefore, we must define and use discrete differentiation. There are several finite difference methods, but I think the central difference method may be more effective because images require determining the boundary with the surroundings. Additionally, it may be difficult to process ambiguous boundaries due to noise or staircase effects. In this case, we can consider intentionally blurring the image so that the edges cannot be considered, or readjusting the image through a filter.

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