

Mech 568 - Assignment 01 - Finite Difference

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Problem 1

1.a

I used the 20-year wintertime North American surface temperature. I chose six clusters for this analysis. The analysis was done for 100 iterations but the results were the same for all the iterations more than 10.

$$\frac{\partial^2 P}{\partial t^2} = c^2 \frac{\partial^2 P}{\partial x^2}$$

$$r = \frac{c^2 \Delta t^2}{\Delta x^2}$$

Explicit method:

$$P_{k+1,i} = rP_{k,i-1} + [2 - 2r]P_{k,i} + rP_{k,i+1} - P_{k-1,i}$$

Implicit method:

$$P_{k,i} - \frac{1}{2}P_{k-1,i} = -\frac{r}{2}P_{k+1,i-1} + \frac{(2r+1)}{2}P_{k+1,i} - \frac{r}{2}P_{k+1,i+1}$$

1.b

Done.

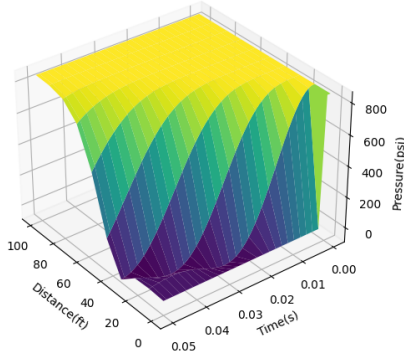
1.c

The six cluster centroids are shown in Figure 1.

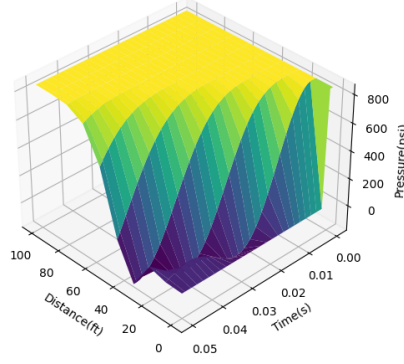
1.d

Done.

Numerical Solution of 1D Wave Equation-implicit



Numerical Solution of 1D Wave Equation-explicit



Difference between Explicit and Implicit Solutions

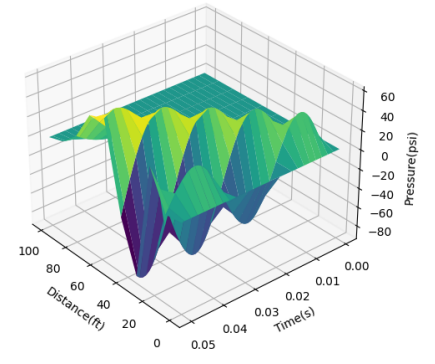


Figure 1: The six clusters for the analysis of temeptrature anamolies in the winters of North America

1.e

To interpret the clusters in figure 1,

- Cluster 1: It is warmer in Florida and Mexico region and colder on other parts of the US and Canada.
- Cluster 2: The temperature is the highest in the west and lower in the east.
- Cluster 3: It is warmer on the east side of the Rocky Mountains and colder on the west side.
- Cluster 4: The temperature is generally warm, and it is warmer in the north.
- Cluster 5: The temperature is lower in the North and warmer in the south.
- Cluster 6: It is cold in the south-eastern part of the US and mild in the north-western part.

The figure 2 shows the number of data points in each cluster. It shows that cluster 2 has the most data points it means that non-harsh winters are more common with the temperature being mildly higher in the west. and the fewest data points are in cluster 1 and 5. These clusters show the temperature in what regions are most probable to correlate with each other.