

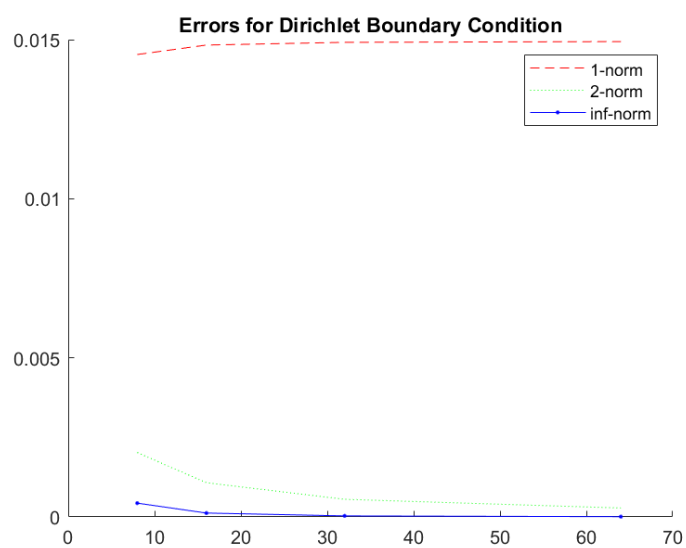
Numerical Analysis Project #1

3190300985 LUIS LUZERN YUVEN

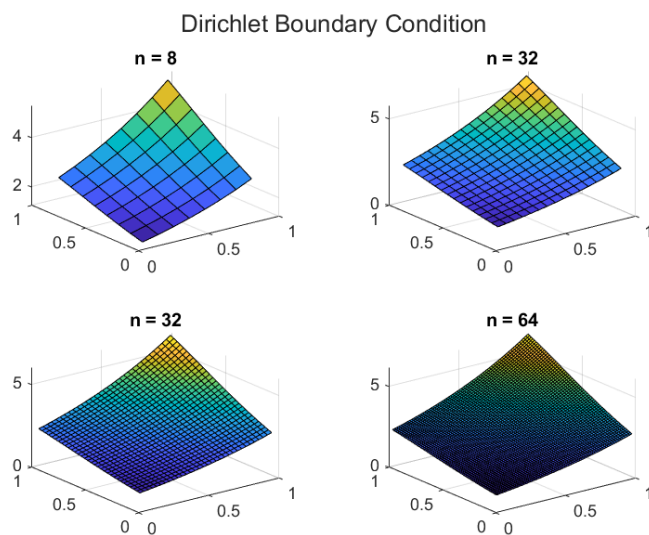
March 31, 2022

1 Problem Domain $(0, 1)^2$

1.1 Dirichlet Boundary Condition



(a) Errors of Dirichlet Boundary Condition



(b) Solutions of Dirichlet Boundary Condition

1.2 Pure Neumann Boundary Condition

We have to modify the system of linear equations into

$$\begin{bmatrix} A & 1 \\ 1^T & 0 \end{bmatrix} \begin{bmatrix} x \\ \lambda \end{bmatrix} = \begin{bmatrix} f \\ 0 \end{bmatrix}.$$

to get a solution, where λ is a known value (can be set to the average of all the U'_{ij} s), otherwise the matrix will be a singular matrix, hence no solution.

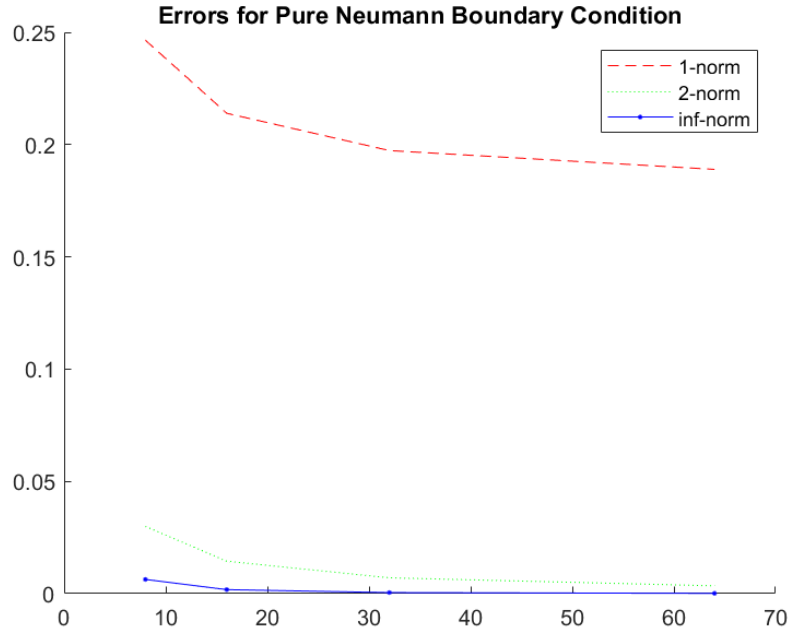


Figure 2: Errors of Pure Neumann Boundary Condition

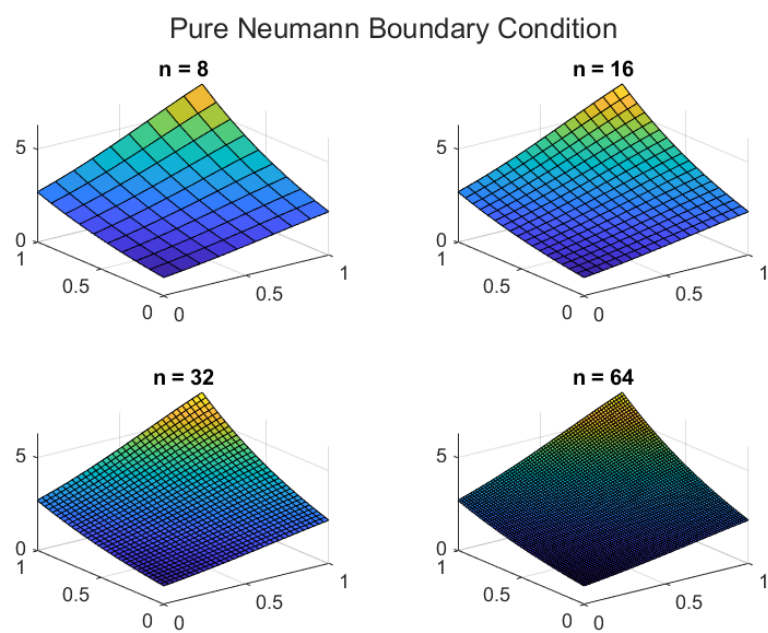
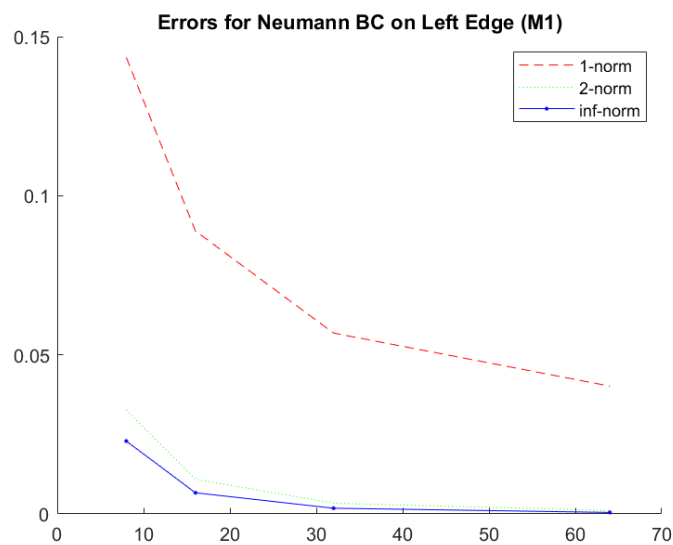
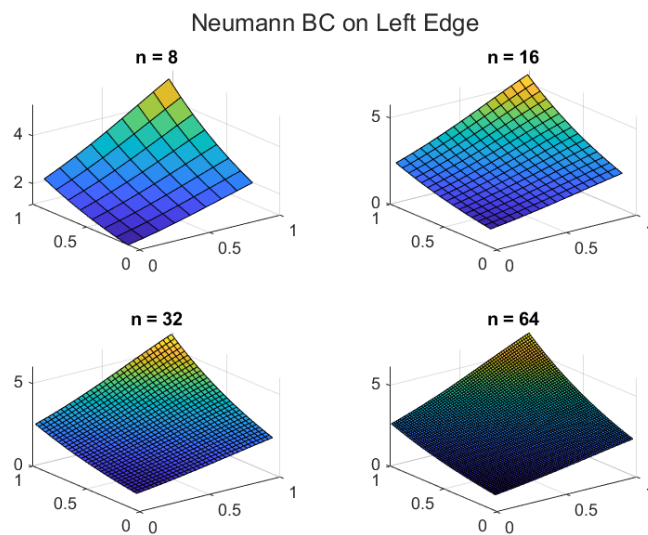


Figure 3: Solutions of Pure Neumann Boundary Condition

1.3 Neumann Boundary Condition on Left Edge

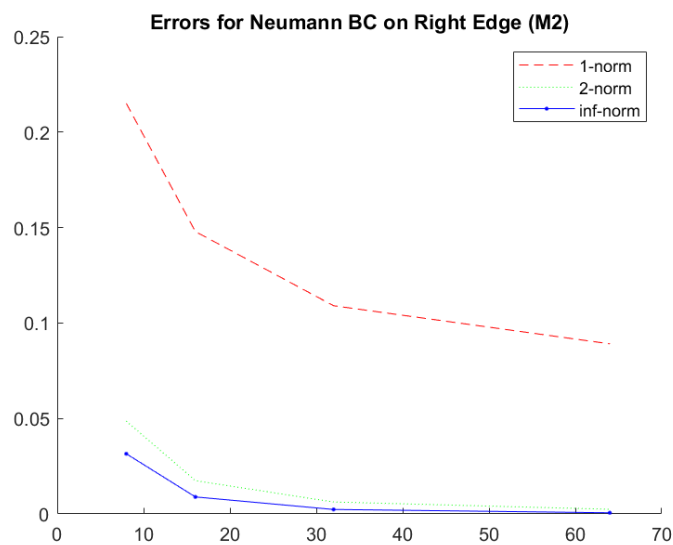


(a) Errors of Neumann Boundary Condition on Left Edge

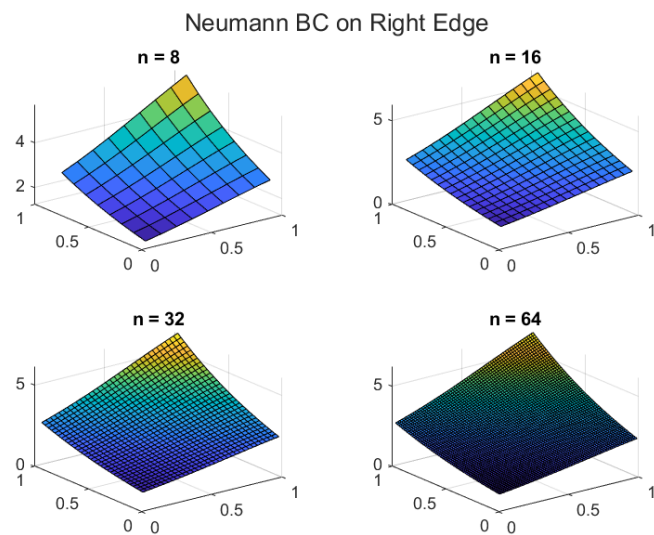


(b) Solutions of Neumann Boundary Condition on Left Edge

1.4 Neumann Boundary Condition on Right Edge

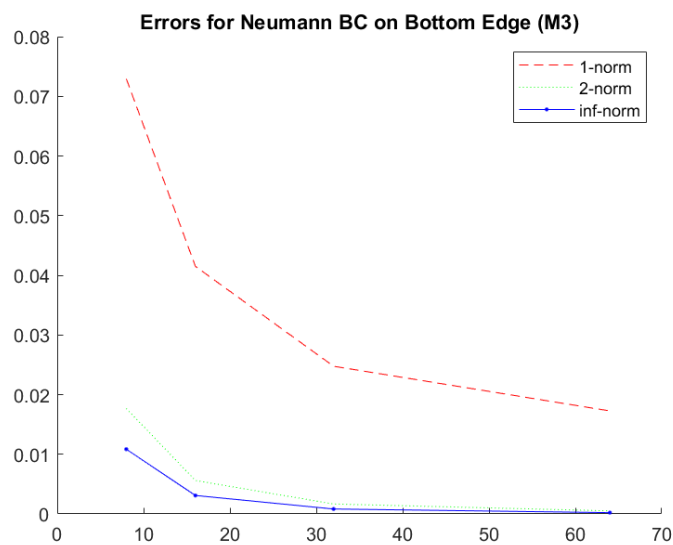


(a) Errors of Neumann Boundary Condition on Right Edge

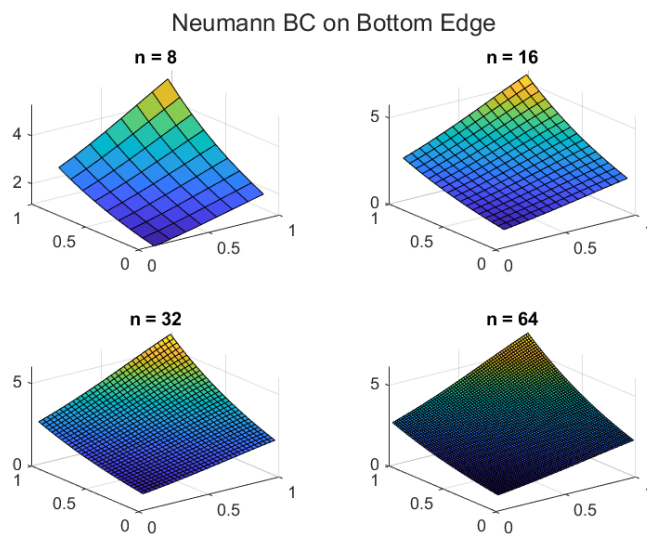


(b) Solutions of Neumann Boundary Condition on Right Edge

1.5 Neumann Boundary Condition on Bottom Edge

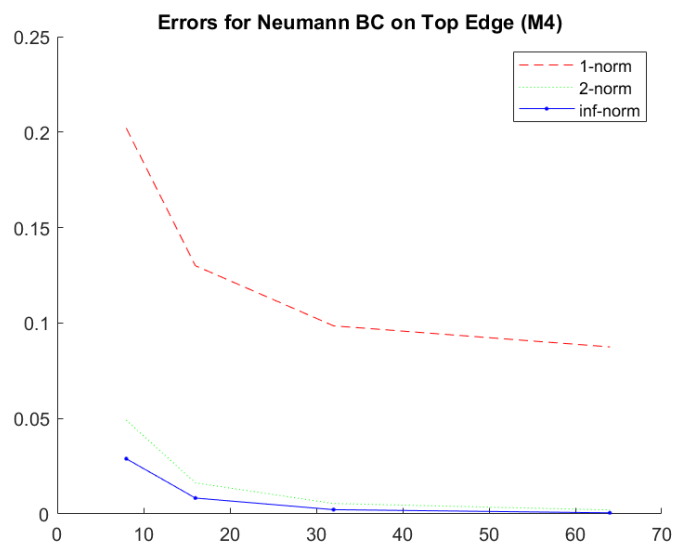


(a) Errors of Neumann Boundary Condition on Bottom Edge

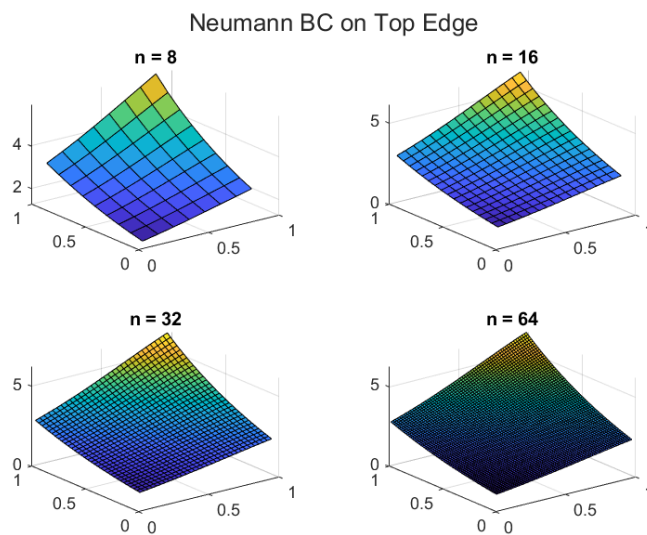


(b) Solutions of Neumann Boundary Condition on Bottom Edge

1.6 Neumann Boundary Condition on Top Edge

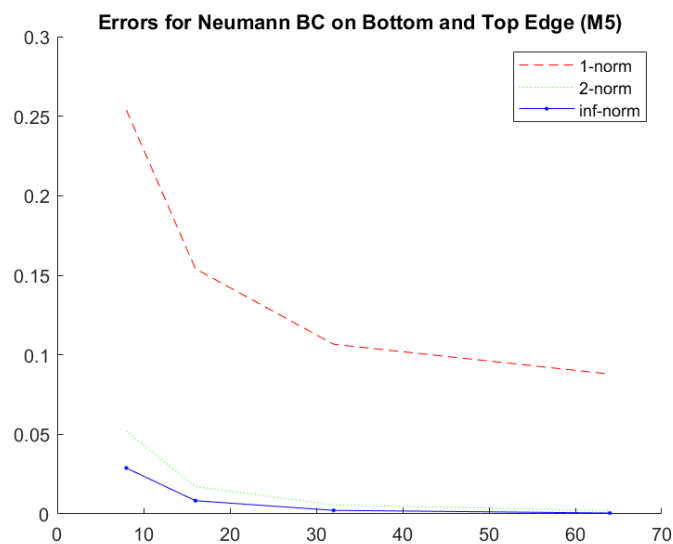


(a) Errors of Neumann Boundary Condition on Top Edge

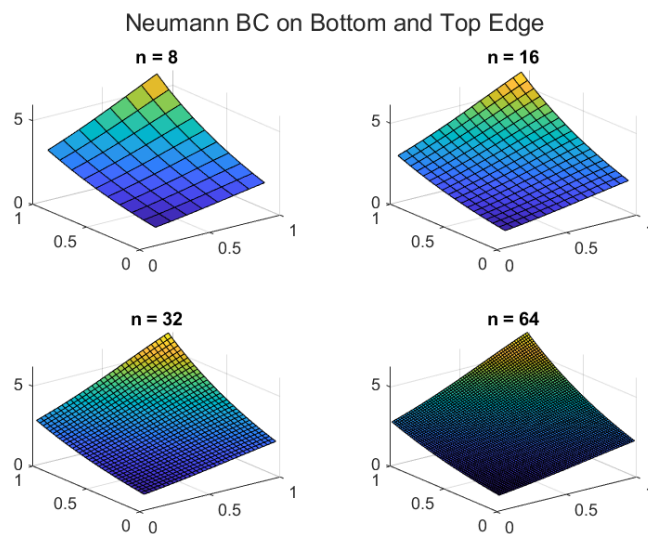


(b) Solutions of Neumann Boundary Condition on Top Edge

1.7 Neumann Boundary Condition on Bottom and Top Edge

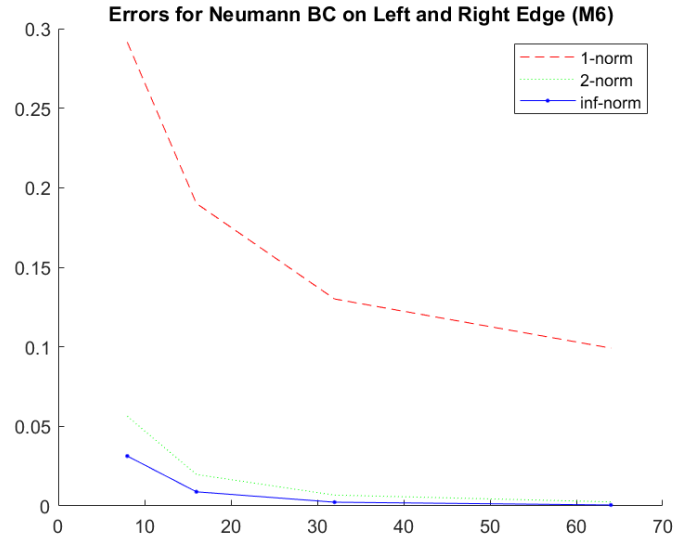


(a) Errors of Neumann Boundary Condition on Bottom and Top Edge

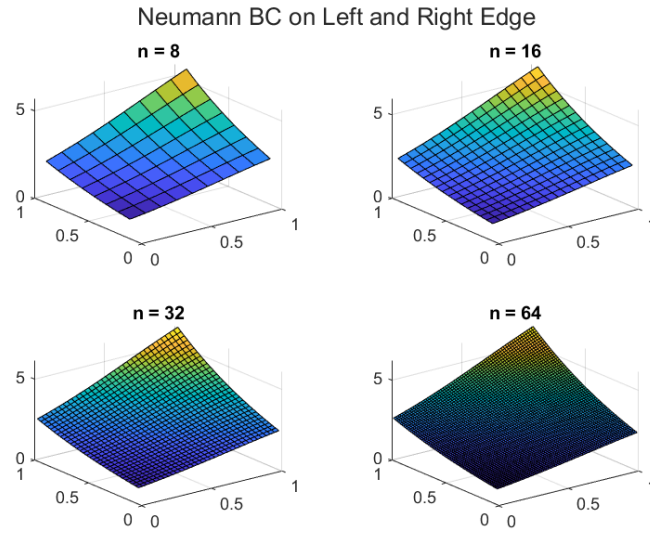


(b) Solutions of Neumann Boundary Condition on Bottom and Top Edge

1.8 Neumann Boundary Condition on Left and Right Edge

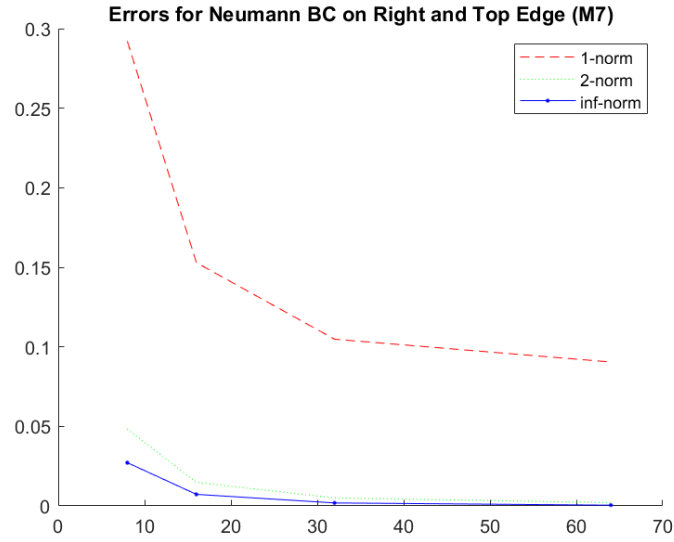


(a) Errors of Neumann Boundary Condition on Left and Right Edge

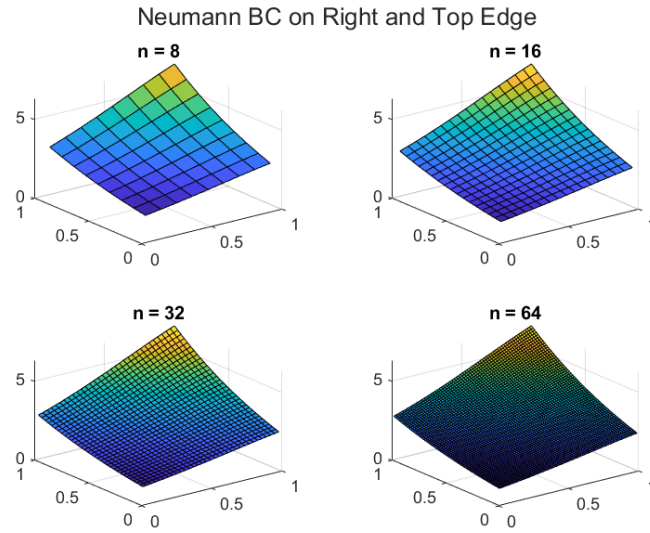


(b) Solutions of Neumann Boundary Condition on Left and Right Edge

1.9 Neumann Boundary Condition on Right and Top Edge

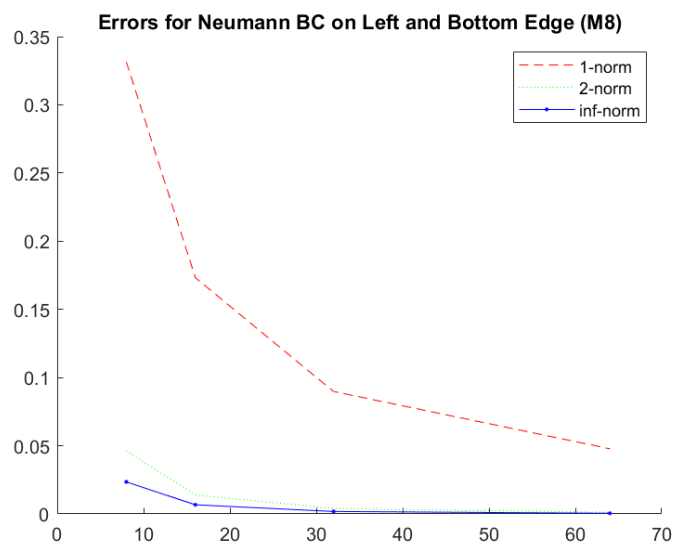


(a) Errors of Neumann Boundary Condition on Right and Top Edge

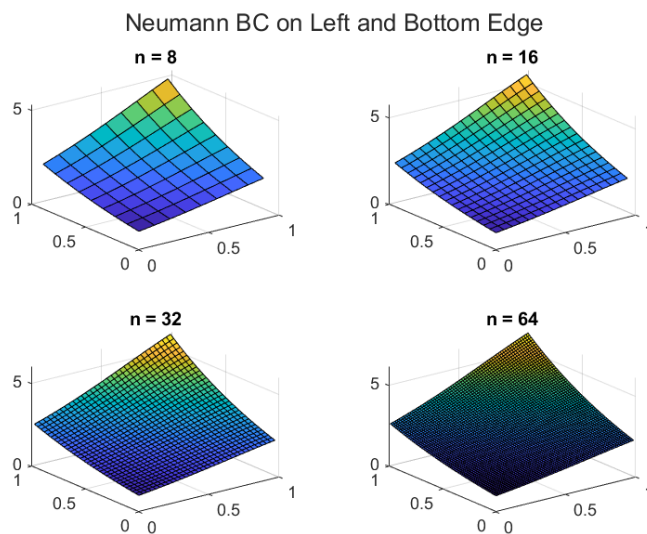


(b) Solutions of Neumann Boundary Condition on Right and Top Edge

1.10 Neumann Boundary Condition on Left and Bottom Edge

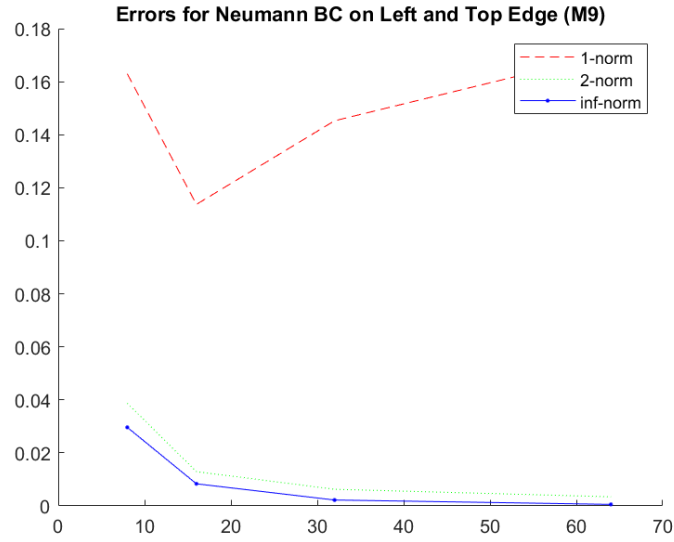


(a) Errors of Neumann Boundary Condition on Left and Bottom Edge

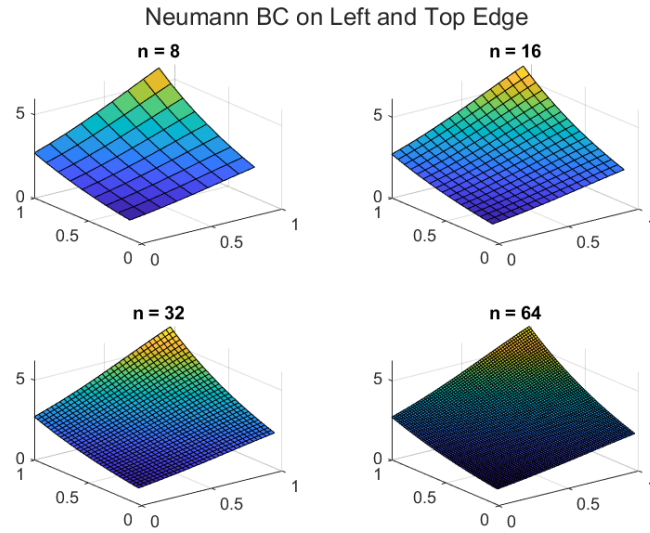


(b) Solutions of Neumann Boundary Condition on Left and Bottom Edge

1.11 Neumann Boundary Condition on Left and Top Edge

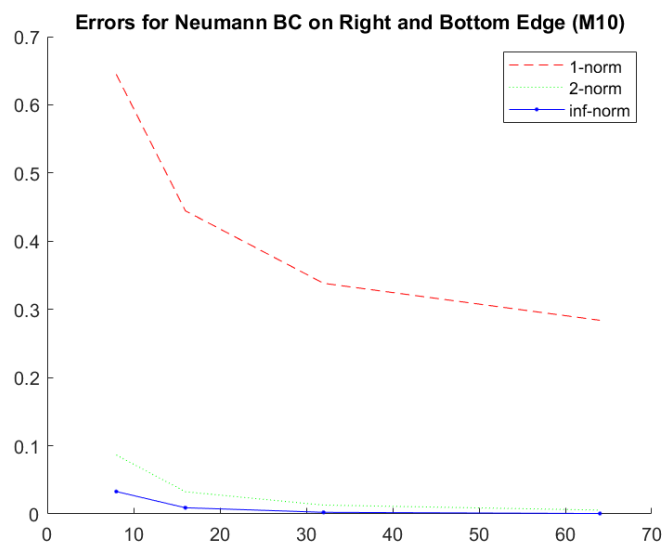


(a) Errors of Neumann Boundary Condition on Left and Bottom Edge

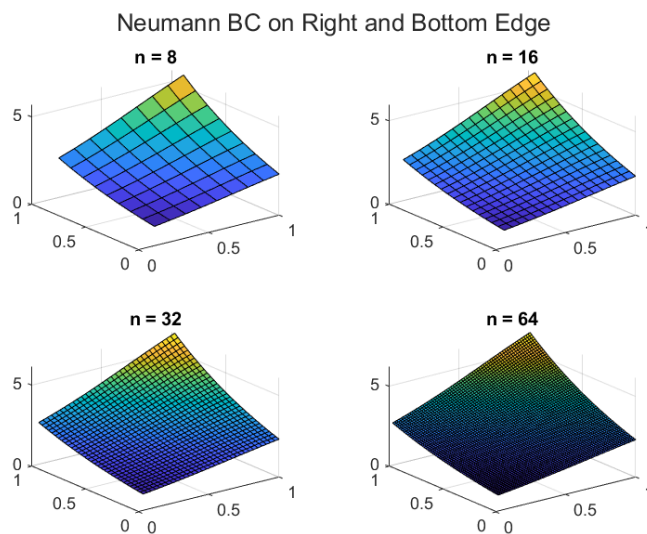


(b) Solutions of Neumann Boundary Condition on Left and Bottom Edge

1.12 Neumann Boundary Condition on Right and Bottom Edge

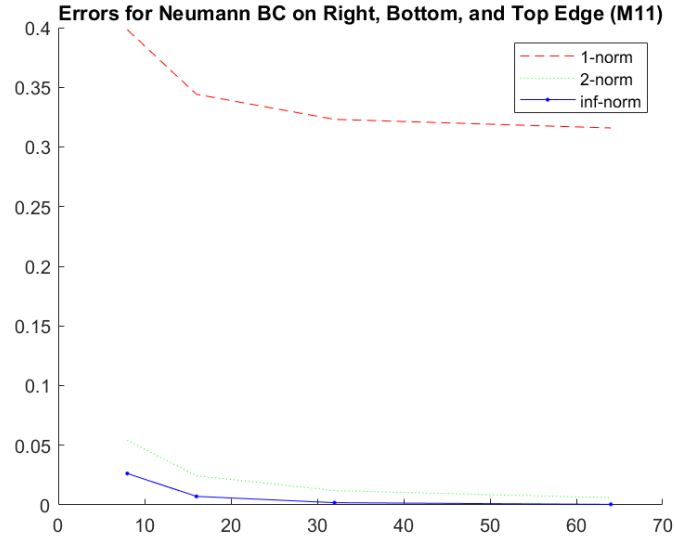


(a) Errors of Neumann Boundary Condition on Right and Bottom Edge

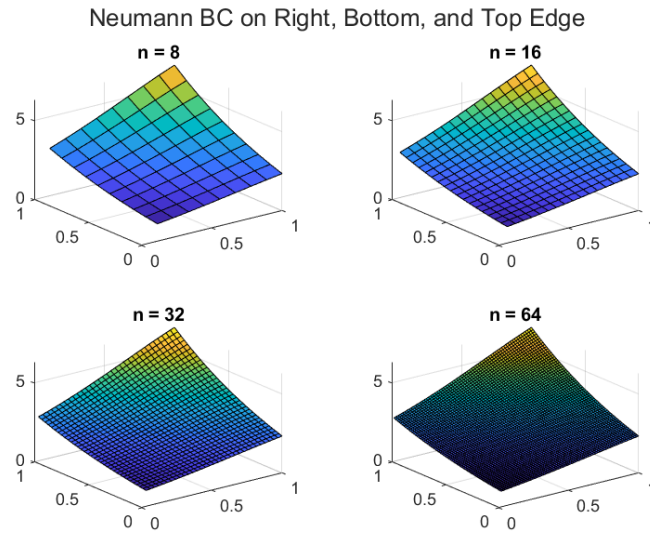


(b) Solutions of Neumann Boundary Condition on Right and Bottom Edge

1.13 Neumann Boundary Condition on Right, Bottom, and Top Edge

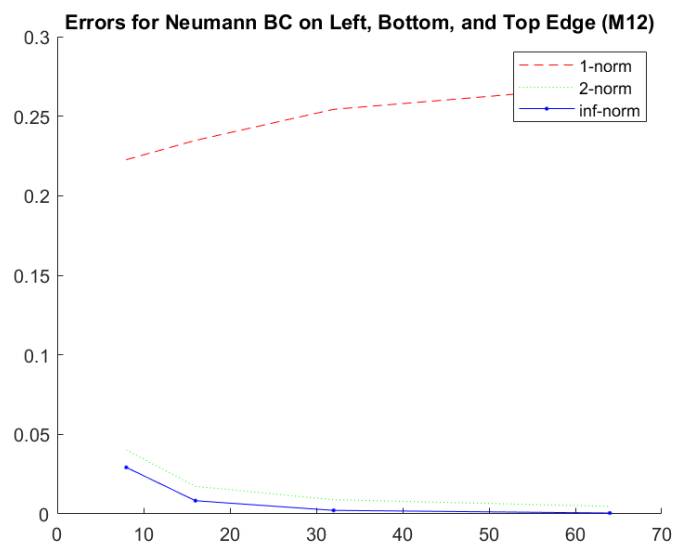


(a) Errors of Neumann Boundary Condition on Right, Bottom, and Top Edge

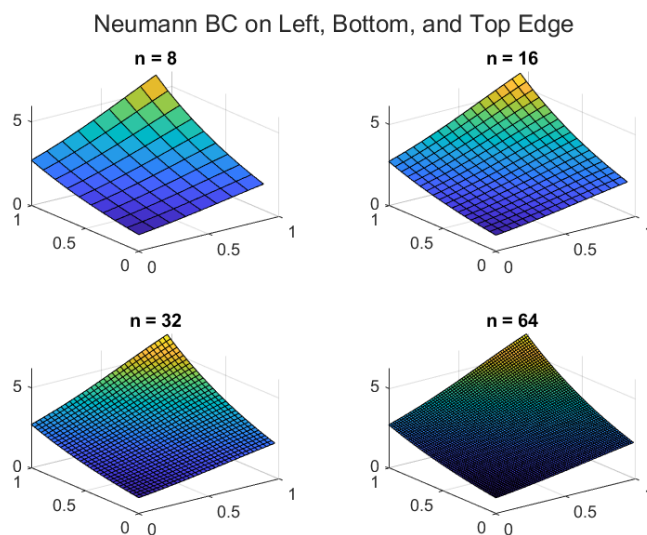


(b) Solutions of Neumann Boundary Condition on Right, Bottom, and Top Edge

1.14 Neumann Boundary Condition on Left, Bottom, and Top Edge

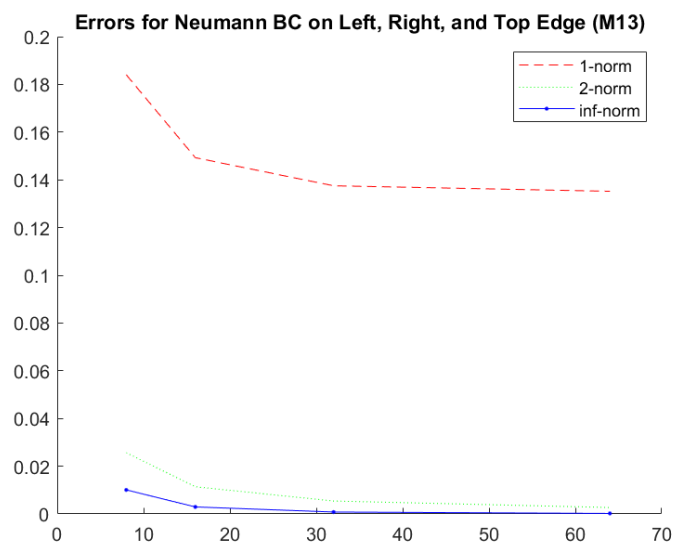


(a) Errors of Neumann Boundary Condition on Left, Bottom, and Top Edge

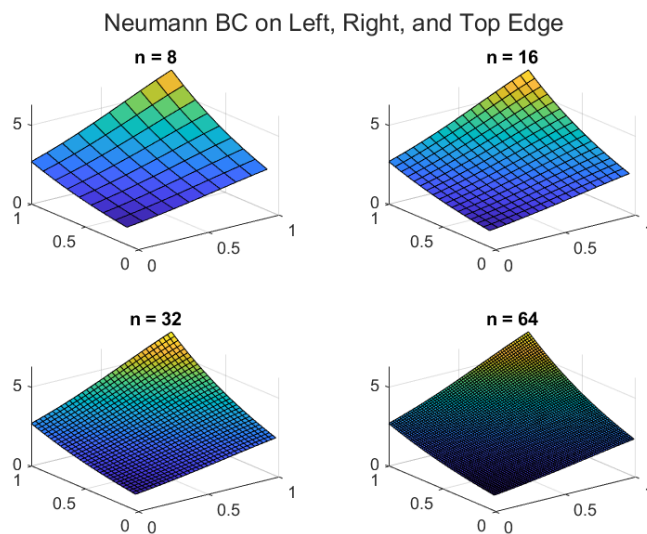


(b) Solutions of Neumann Boundary Condition on Left, Bottom, and Top Edge

1.15 Neumann Boundary Condition on Left, Right, and Top Edge

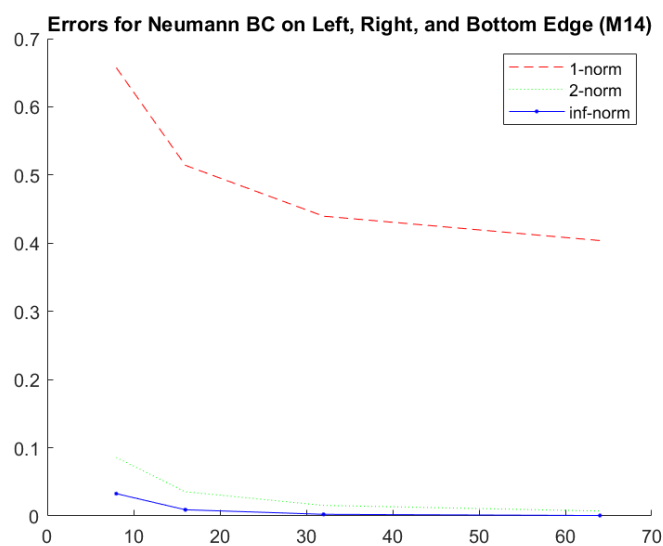


(a) Errors of Neumann Boundary Condition on Left, Right, and Top Edge

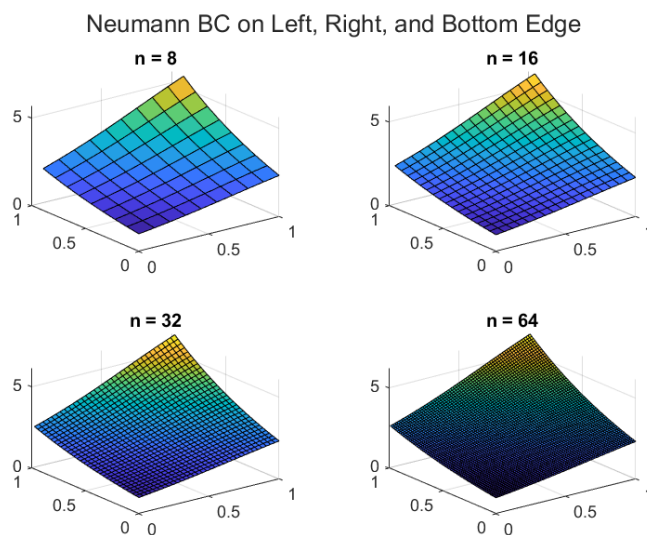


(b) Solutions of Neumann Boundary Condition on Left, Right, and Top Edge

1.16 Neumann Boundary Condition on Left, Right, and Bottom Edge



(a) Errors of Neumann Boundary Condition on Left, Right, and Bottom Edge



(b) Solutions of Neumann Boundary Condition on Left, Right, and Bottom Edge

From the graphs shown above, it is verified that we get second-order convergence in the 2-norm and the max-norm, while the same cannot be said for the 1-norm, since the 1-norm for all n (8, 16, 32, 64) are above 0.1, or even increases as n increases in some cases.