Numerical Engineering Analysis (MAE-5093)
Home Work - 6

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1 Problem

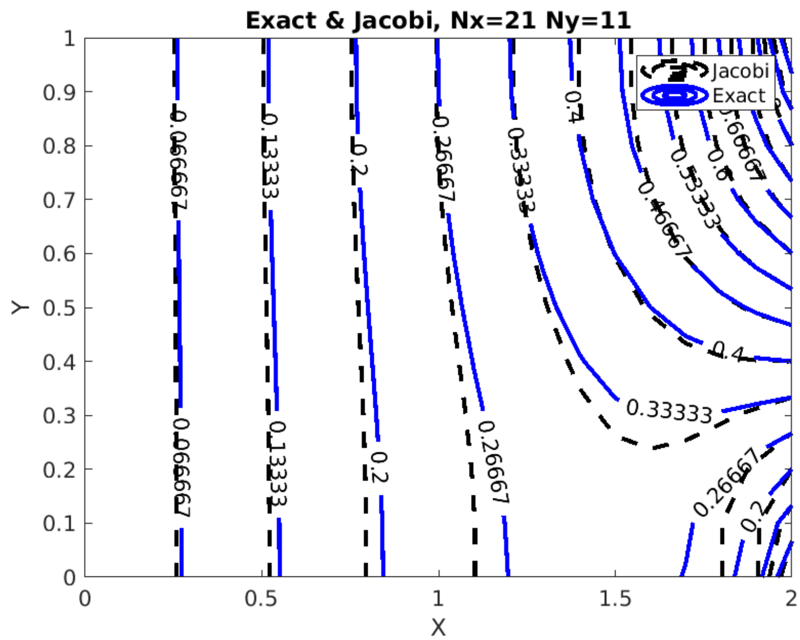
The steady state temperature distribution $u(x, y)$ in a rectangular copper plate satisfies Laplace's equation:

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0 \tag{1}$$

The upper and lower boundaries are perfectly insulated ($\frac{\partial u}{\partial y} = 0$); the left side is kept at $0°C$, and the right side at $f(y) = y°C$.

1.1 Part (a)

Results plotted for part(a):

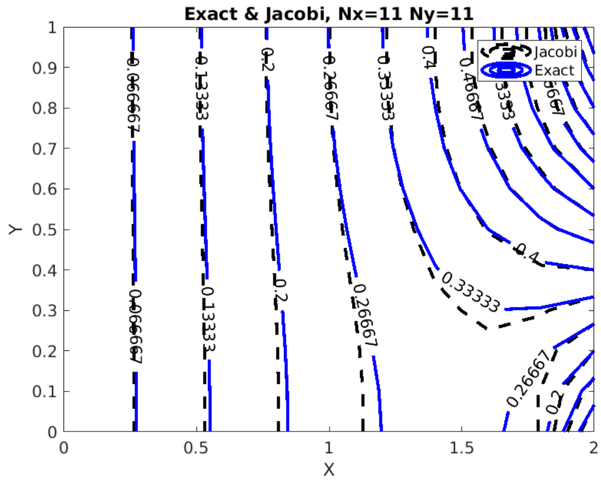


(a) Nx=21, Ny=11

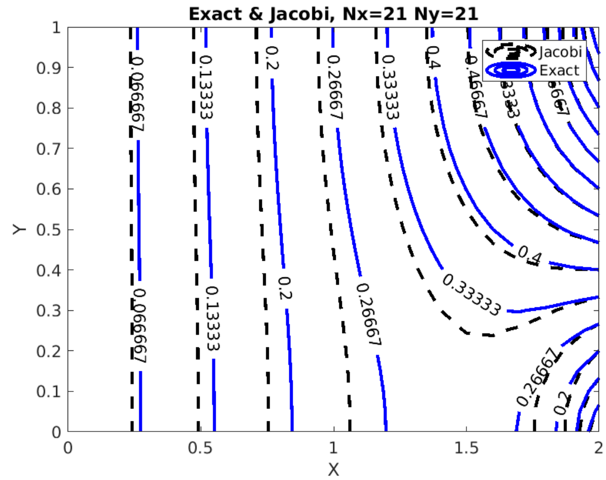
Figure 1: Temperature distribution using Jacobi method when the grid size is kept uniform.

1.2 Part (b)

Results plotted for part(b):



(a) Nx=11,Ny=11

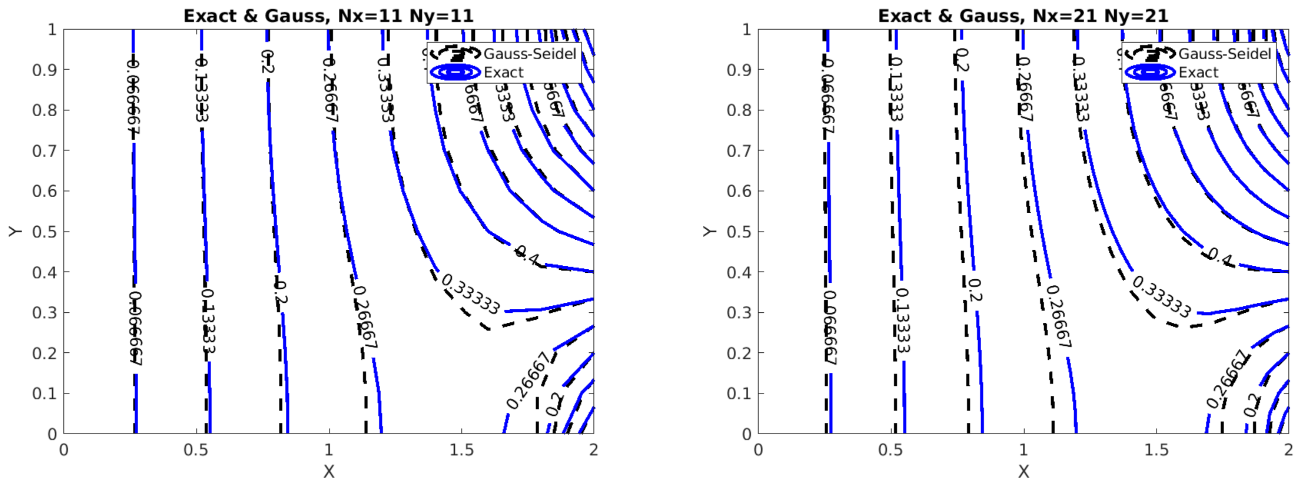


(b) Nx=21,Ny=21

Figure 2: Temperature distribution using Jacobi method when the grid size is kept non-uniform.

1.3 Part (c)

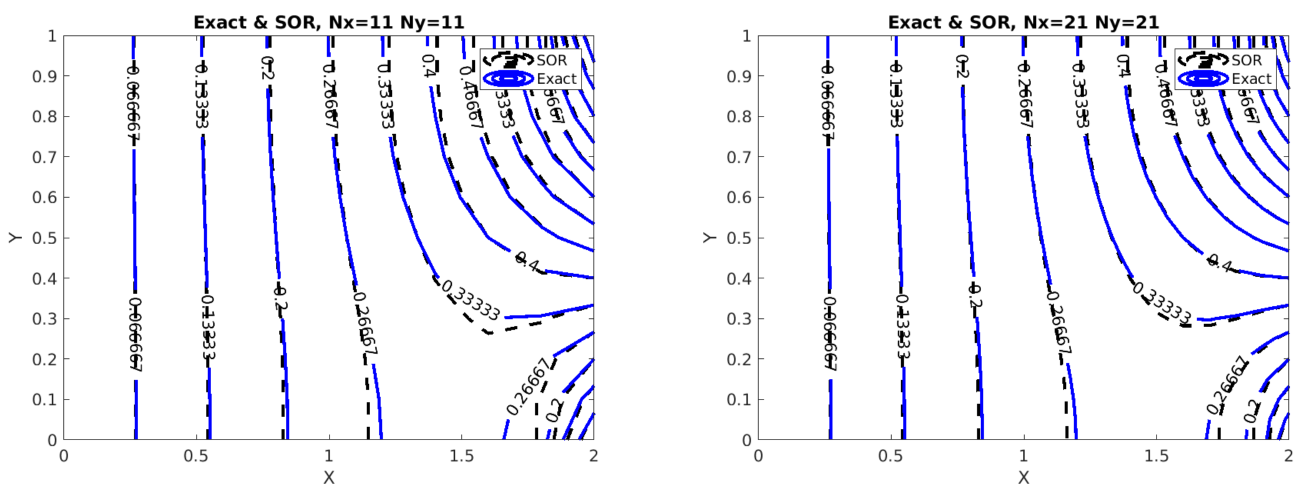
Results plotted for part(c):



(a) Nx=11,Ny=11

(b) Nx=21,Ny=21

Figure 3: Temperature distribution using Gauss-Seidel method when the grid size is kept non-uniform.



(a) Nx=11,Ny=11

(b) Nx=21,Ny=21

Figure 4: Temperature distribution using SOR method when the grid size is kept non-uniform.

Conclusion:

Table 1: Results

Cases	Iteration required	Absolute error	Percentage error
Jacobi(Nx=21,Ny=11)	620	0.0072	2.86
Jacobi(Nx=11,Ny=11)	438	0.0042	1.66
Jacobi(Nx=21,Ny=21)	1163	0.0193	7.72
Gauss-Seidel(Nx=11,Ny=11)	276	0.0019	0.76
Gauss-Seidel(Nx=21,Ny=21)	747	0.0096	3.85
SOR(Nx=11,Ny=11)	71	0.00005	0.0219
SOR(Nx=21,Ny=21)	177	0.0007	0.30