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```
%{

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Description:
AME 60614: Numerical Methods
Homework: 8
Due: 12/12/2024


%}
```

Preperation of the workspace

```
clear all
clc
close all
fontsize = 16;


% set(0,'DefaultFigureWindowStyle','default')
set(0,'DefaultTextInterpreter','latex')
set(0,'DefaultAxesFontSize',fontsize)
set(0,'DefaultLegendFontSize',fontsize)
colors  = ["#000000","#1b9e77","#d95f02","#7570b3","#0099FF"]';
```

Setting data paths

Make sure to update this for the machine that you are working on. (Maybe, This should now run on any machine without change. 7/24/24) Change the current folder to the folder of this m-file.

```
if(~isdeployed)
  cd(fileparts(matlab.desktop.editor.getActiveFilename));
end

addpath(cd)
% cd ..; % Moving up a directory (from processing_code)
basepath = cd; % Pulling the current directory


imagepath = [basepath filesep 'images' filesep];
mkdir(imagepath);
```

```
Warning: Directory already exists.
```

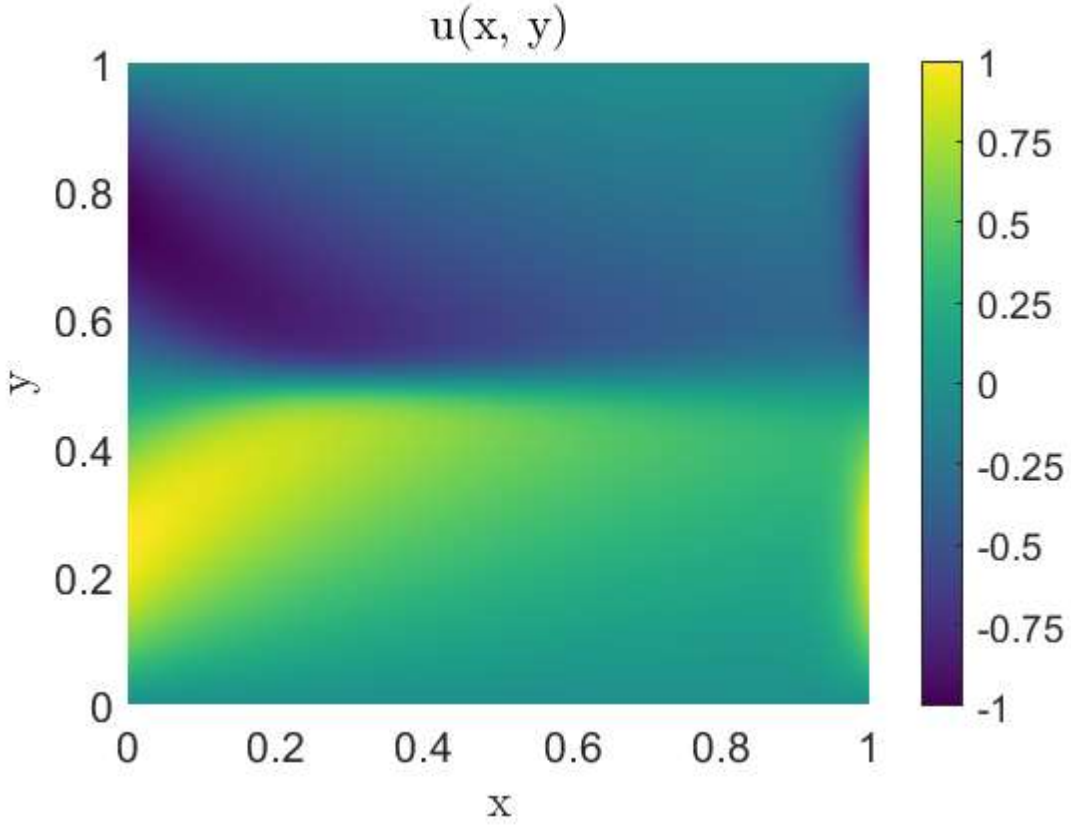
Chapter 10 Problem 5

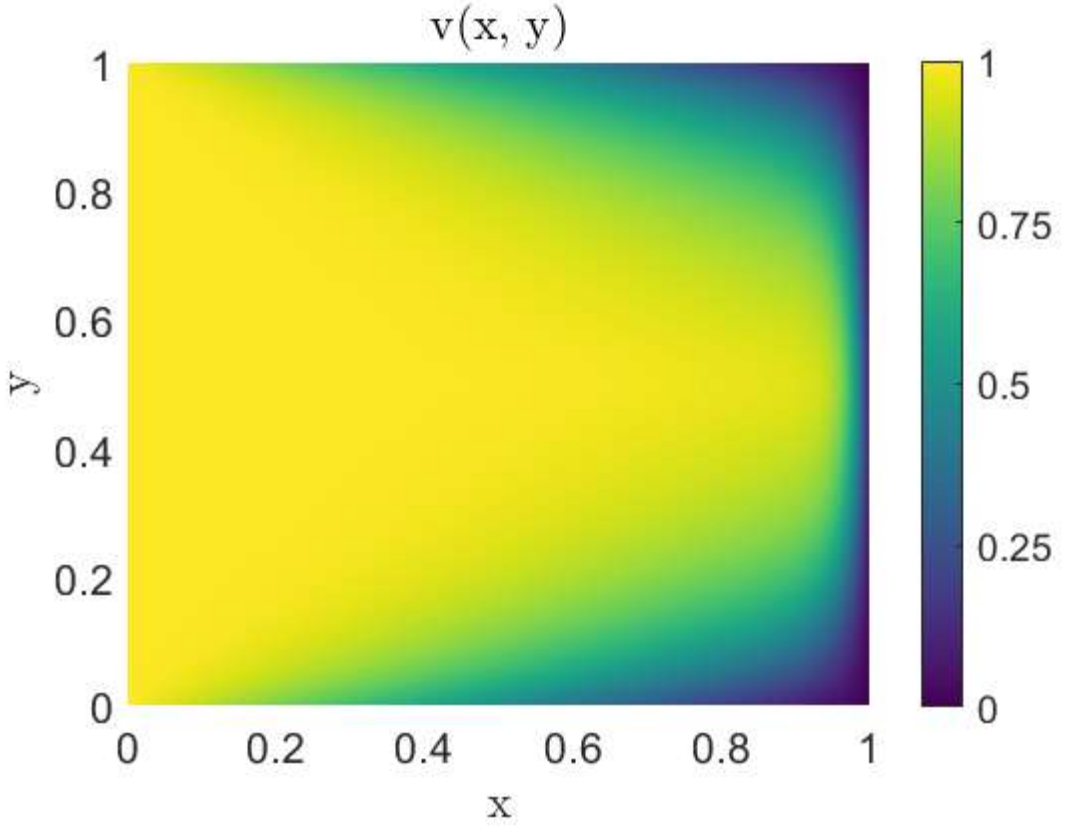
```
% Parameters
nu = 0.015;
N = 200; % Number of grid points
L = 1; % Domain length
h = L / (N - 1); % Grid spacing
dt = 0.0001; % Time step
tolerance = 1e-6; % Steady state tolerance
maxIter = 1e5; % Maximum iterations

x = linspace(0, L, N);
y = linspace(0, L, N);
[X, Y] = meshgrid(x, y);

u = zeros(N, N);
v = zeros(N, N);

% Boundary conditions
u(:, 1) = sin(2 * pi * x); % u(x, 0)
u(:, end) = sin(2 * pi * x); % u(x, 1)
v(1, :) = 1 - y; % v(0, y)
v(end, :) = 1 - y; % v(1, y)

% Time-stepping
for iter = 1:maxIter
    u_old = u;
    v_old = v;

    % u
    for i = 2:N-1
        for j = 2:N-1
            u(i, j) = u_old(i, j) - dt * ( ...
                u_old(i, j) * (u_old(i+1, j) - u_old(i-1, j)) / (2 * h) + ...
                v_old(i, j) * (u_old(i, j+1) - u_old(i, j-1)) / (2 * h) ) ...
                + nu * dt * ( ...
                (u_old(i+1, j) - 2*u_old(i, j) + u_old(i-1, j)) / h^2 + ...
                (u_old(i, j+1) - 2*u_old(i, j) + u_old(i, j-1)) / h^2);
        end
    end

    % v
    for i = 2:N-1
        for j = 2:N-1
            v(i, j) = v_old(i, j) - dt * ( ...
                u_old(i, j) * (v_old(i+1, j) - v_old(i-1, j)) / (2 * h) + ...
                v_old(i, j) * (v_old(i, j+1) - v_old(i, j-1)) / (2 * h) ) ...
                + nu * dt * ( ...
                (v_old(i+1, j) - 2*v_old(i, j) + v_old(i-1, j)) / h^2 + ...
                (v_old(i, j+1) - 2*v_old(i, j) + v_old(i, j-1)) / h^2);
        end
    end

    % Boundary conditions
    u(:, 1) = sin(2 * pi * x); % u(x, 0)
    u(:, end) = sin(2 * pi * x); % u(x, 1)
    v(1, :) = 1 - y; % v(0, y)
    v(end, :) = 1 - y; % v(1, y)
    v(:, 1) = 1; % v(x, 0)
    v(:, end) = 0; % v(x, 1)
```

```
    % Convergence
    if max(max(abs(u - u_old))) < tolerance && max(max(abs(v - v_old))) < tolerance
        disp(['Converged in ', num2str(iter), ' iterations.']);
        break;
    end
end


figure;
f = pcolor(X, Y, u)
set(f, 'edgecolor','none')
title('u(x, y)')
xlabel('x'); ylabel('y'); zlabel('u');
colormap viridis
a = colorbar
set(a,'YTick',-1:.25:1)
set(gca, 'CLim', [-1 1])
print(gcf,[imagepath,'u.png'],'-dpng');


figure
f = pcolor(X, Y, v)
set(f, 'edgecolor','none')
title('v(x, y)')
xlabel('x'); ylabel('y'); zlabel('v');
colormap viridis
a = colorbar
set(a,'YTick',0:.25:1)
set(gca, 'CLim', [0 1])
print(gcf,[imagepath,'v.png'],'-dpng');
```

```
Converged in 26021 iterations.

f =

  Surface with properties:

      EdgeColor: [0 0 0]
      LineStyle: '-'
      FaceColor: 'flat'
    FaceLighting: 'flat'
      FaceAlpha: 1
          XData: [200×200 double]
          YData: [200×200 double]
          ZData: [200×200 double]
          CData: [200×200 double]

  Use GET to show all properties


a =

  ColorBar with properties:

    Location: 'eastoutside'
      Limits: [-1.0000 1.0000]
    FontSize: 14.4000
    Position: [0.8315 0.1500 0.0381 0.7690]
```

```
      Units: 'normalized'

  Use GET to show all properties


f =

  Surface with properties:

      EdgeColor: [0 0 0]
      LineStyle: '-'
      FaceColor: 'flat'
    FaceLighting: 'flat'
      FaceAlpha: 1
          XData: [200×200 double]
          YData: [200×200 double]
          ZData: [200×200 double]
          CData: [200×200 double]

  Use GET to show all properties


a =

  ColorBar with properties:

    Location: 'eastoutside'
      Limits: [0 1]
    FontSize: 14.4000
    Position: [0.8315 0.1500 0.0381 0.7690]
      Units: 'normalized'

  Use GET to show all properties
```





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