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%% HW #10 Numerical Stability
clear

% Integration parameters
Nx=21;
Lx=1;
dt= 0.0005;
Nt= 1/dt;
dx=Lx/(Nx-1);
x=dx*[0:Nx-1];
s=dt/dx^2;
% As s approaches 1/2, numerical solutions begin to appear
jagged and
% broken. Lower s numbers guarantee stability, but come at
the price of
% slow convergence.

% Equation Parameters
mu = 0.5;
gamma = 1;
T_inf = 1.5;
T_0 = 1;

% Initial values
T(1:Nx) = T_0;
Tn=T; % temporary storage
t=0;

% Number of snapshots
N_shot=40;
N_inc=floor(Nt/N_shot);
figure
plot(x,T,'-','LineWidth',2)
% ylim([0 1])
xlabel('x'), ylabel('T')
timemarker = text(0.05,1.3,['t=',num2str(t)]);
sparam = text(0.05,1.25,['s=',num2str(s)]);
video = VideoWriter('FTCS.avi');
open(video)
pause

% Time integration
for n=1:Nt
    % Advance internal values

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for j=2:Nx-1
    % Calculating Subfunctions
    A = 0.18 * (1- mu * x(j));
    A_deriv = -0.18 * mu;
    l = 1.5 * sqrt(1 - mu*x(j));

    %Calculating Psuedocoefficients
    aj = dt/(dx^2) - 0.5 * ((A_deriv * dt) / (A * dx));
    bj = 1 - 2 * (dt/(dx^2)) - gamma * (l/A) * dt;
    cj = dt/(dx^2) + 0.5 * ((A_deriv * dt) / (A * dx));
    dj = gamma * (l/A) * T_inf * dt;

    % Calculate Equation
    T(j) = aj*Tn(j-1) + bj*Tn(j) + cj*Tn(j+1) + dj;
end
frame = getframe(gcf);
writeVideo(video,frame);
% Advance time and set Boundary values
t=t+dt;
% Initial boundary condition
T(1) = T_0;

% Endpoint boundary condition
% Calculating Subfunctions
ANx = 0.18 * (1- mu * x(Nx));
A_derivNx = -0.18 * mu;
lNx = 1.5 * sqrt(1 - mu * x(Nx));

%Calculating Psuedocoefficients
aNx = dt/(dx^2) - 0.5 * ((A_derivNx * dt) / (ANx *
dx));
bNx = 1 - 2 * (dt/(dx^2)) - gamma * (lNx/ANx) * dt;
cNx = dt/(dx^2) + 0.5 * ((A_derivNx * dt) / (ANx * dx));
dNx = gamma * (lNx/ANx) * T_inf * dt;

T(Nx) = (aNx + cNx) * Tn(Nx-1) + (bNx +
2*dx*gamma*cNx)*T(Nx) - 2*cNx*dx*gamma*T_inf + dNx;
% Store solution in temporary array
Tn=T;
% Take a snapshot every N_inc steps
if mod(n,N_inc)== 0
    delete(timemarker)
    hold on
    plot(x,T, '-','LineWidth',2)

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        xlabel('x'), ylabel('T')
        timemarker = text(0.05,1.3,['t=',num2str(t)]);
        sparam = text(0.05,1.25,['s=',num2str(s)]);
        pause(0.05)
    end
end

close(video);
```