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```
%Tyler Matthews
%System Simluation Midterm P5
clc; close all; %Clear Console and Close Figures
```

PART A

```
N = 10000;
t = linspace(0,10,N);
u = ones(1,N);
stable_acc = 0.05; %Stable for predictor

fx1c = zeros(1,N);
fx2c = zeros(1,N);
fx3c = zeros(1,N);

x1p = zeros(1,N);
x2p = zeros(1,N);
x3p = zeros(1,N);

fx1p = zeros(1,N);
fx2p = zeros(1,N);
fx3p = zeros(1,N);

x1c = zeros(1,N);
x2c = zeros(1,N);
x3c = zeros(1,N);
y = zeros(1,N);

%Predict
x1p(1) = 0;
x2p(1) = 0;
x3p(1) = 0;

fx1p(1) = -4.7*x1p(1)-1.55*x2p(1)-0.55*x3p(1)+u(1);
fx2p(1) = 0.3*x1p(1)-2.75*x2p(1)-0.35*x3p(1);
fx3p(1) = 1.1*x1p(1)+1.85*x2p(1)-2.55*x3p(1)-u(1);

%Correct
x1c(1) = stable_acc * (0.46*fx1p(1));
x2c(1) = stable_acc * (0.46*fx2p(1));
x3c(1) = stable_acc * (0.46*fx3p(1));

fx1c(1) = -4.7*x1c(1)-1.55*x2c(1)-0.55*x3c(1)+u(1);
fx2c(1) = 0.3*x1c(1)-2.75*x2c(1)-0.35*x3c(1);
fx3c(1) = 1.1*x1c(1)+1.85*x2c(1)-2.55*x3c(1)-u(1);
```

```

y(1) = 2*x1c(1)+x2c(1)+x3c(1);

%Predict
x1p(2) = 1.45*x1c(1) + stable_acc * (1.27*fx1c(1));
x2p(2) = 1.45*x2c(1) + stable_acc * (1.27*fx2c(1));
x3p(2) = 1.45*x3c(1) + stable_acc * (1.27*fx3c(1));

fx1p(2) = -4.7*x1p(2)-1.55*x2p(2)-0.55*x3p(2)+u(2);
fx2p(2) = 0.3*x1p(2)-2.75*x2p(2)-0.35*x3p(2);
fx3p(2) = 1.1*x1p(2)+1.85*x2p(2)-2.55*x3p(2)-u(2);

%Correct
x1c(2) = 1.56*x1c(1) + stable_acc * (0.46*fx1p(2) + 0.29*fx1p(1));
x2c(2) = 1.56*x2c(1) + stable_acc * (0.46*fx2p(2) + 0.29*fx2p(1));
x3c(2) = 1.56*x3c(1) + stable_acc * (0.46*fx3p(2) + 0.29*fx3p(1));

fx1c(2) = -4.7*x1c(2)-1.55*x2c(2)-0.55*x3c(2)+u(2);
fx2c(2) = 0.3*x1c(2)-2.75*x2c(2)-0.35*x3c(2);
fx3c(2) = 1.1*x1c(2)+1.85*x2c(2)-2.55*x3c(2)-u(2);

y(2) = 2*x1c(2)+x2c(2)+x3c(2);

for k = 3:N-2

%Predict
x1p(k) = 1.45*x1c(k-1) - 0.45*x1c(k-2) + stable_acc * (1.27*fx1c(k-1) - 0.73*fx1c(k-2));
x2p(k) = 1.45*x2c(k-1) - 0.45*x2c(k-2) + stable_acc * (1.27*fx2c(k-1) - 0.73*fx2c(k-2));
x3p(k) = 1.45*x3c(k-1) - 0.45*x3c(k-2) + stable_acc * (1.27*fx3c(k-1) - 0.73*fx3c(k-2));

fx1p(k) = -4.7*x1p(k)-1.55*x2p(k)-0.55*x3p(k)+u(k);
fx2p(k) = 0.3*x1p(k)-2.75*x2p(k)-0.35*x3p(k);
fx3p(k) = 1.1*x1p(k)+1.85*x2p(k)-2.55*x3p(k)-u(k);

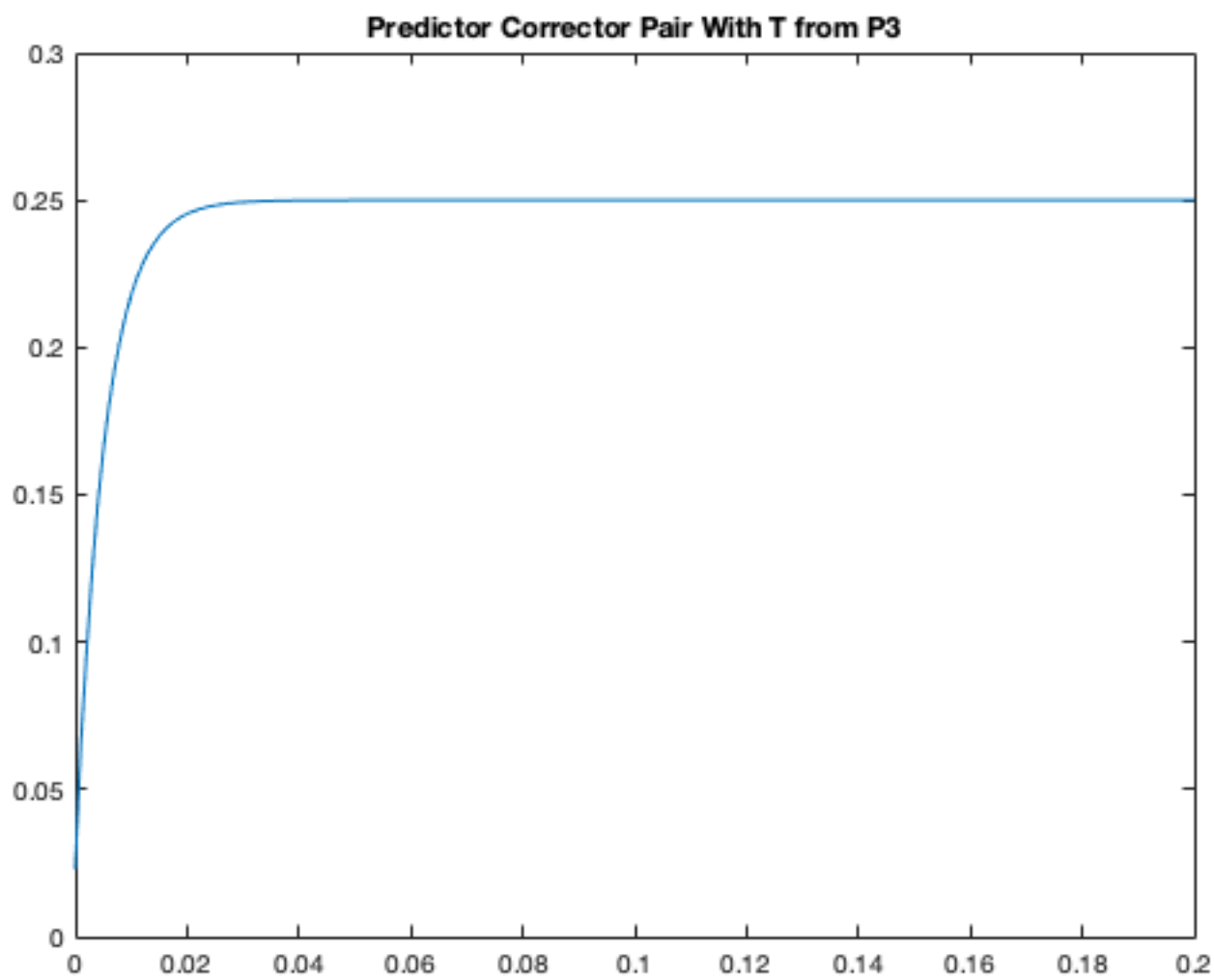
%Correct
x1c(k) = 1.56*x1c(k-1) - 0.56*x1c(k-2) + stable_acc * (0.46*fx1p(k) + 0.29*fx1p(k-1) - 0.3
2*fx1p(k-2));
x2c(k) = 1.56*x2c(k-1) - 0.56*x2c(k-2) + stable_acc * (0.46*fx2p(k) + 0.29*fx2p(k-1) - 0.3
2*fx2p(k-2));
x3c(k) = 1.56*x3c(k-1) - 0.56*x3c(k-2) + stable_acc * (0.46*fx3p(k) + 0.29*fx3p(k-1) - 0.3
2*fx3p(k-2));

fx1c(k) = -4.7*x1c(k)-1.55*x2c(k)-0.55*x3c(k)+u(k);
fx2c(k) = 0.3*x1c(k)-2.75*x2c(k)-0.35*x3c(k);
fx3c(k) = 1.1*x1c(k)+1.85*x2c(k)-2.55*x3c(k)-u(k);

y(k) = 2*x1c(k)+x2c(k)+x3c(k);
end

figure
plot(t,y)
xlim([0 0.2])
title('Predictor Corrector Pair With T from P3')

```



PART B

```
N = 10000;  
t = linspace(0,10,N);  
u = ones(1,N);  
stable_acc = 0.1; %stable for corrector
```

```
fx1c = zeros(1,N);  
fx2c = zeros(1,N);  
fx3c = zeros(1,N);
```

```
x1p = zeros(1,N);  
x2p = zeros(1,N);  
x3p = zeros(1,N);
```

```
fx1p = zeros(1,N);  
fx2p = zeros(1,N);  
fx3p = zeros(1,N);
```

```
x1c = zeros(1,N);  
x2c = zeros(1,N);  
x3c = zeros(1,N);  
y = zeros(1,N);
```

```
x1c(1) = 1;  
x2c(1) = 1;  
x3c(1) = 1;  
x1p(1) = 1;
```

```
x2p(1) = 1;  
x3p(1) = 1;
```

```
%Predict
```

```
x1p(1) = 0;  
x2p(1) = 0;  
x3p(1) = 0;
```

```
fx1p(1) = -4.7*x1p(1)-1.55*x2p(1)-0.55*x3p(1)+u(1);  
fx2p(1) = 0.3*x1p(1)-2.75*x2p(1)-0.35*x3p(1);  
fx3p(1) = 1.1*x1p(1)+1.85*x2p(1)-2.55*x3p(1)-u(1);
```

```
%Correct
```

```
x1c(1) = stable_acc * (0.46*fx1p(1));  
x2c(1) = stable_acc * (0.46*fx2p(1));  
x3c(1) = stable_acc * (0.46*fx3p(1));
```

```
fx1c(1) = -4.7*x1c(1)-1.55*x2c(1)-0.55*x3c(1)+u(1);  
fx2c(1) = 0.3*x1c(1)-2.75*x2c(1)-0.35*x3c(1);  
fx3c(1) = 1.1*x1c(1)+1.85*x2c(1)-2.55*x3c(1)-u(1);
```

```
y(1) = 2*x1c(1)+x2c(1)+x3c(1);
```

```
%Predict
```

```
x1p(2) = 1.45*x1c(1) + stable_acc * (1.27*fx1c(1));  
x2p(2) = 1.45*x2c(1) + stable_acc * (1.27*fx2c(1));  
x3p(2) = 1.45*x3c(1) + stable_acc * (1.27*fx3c(1));
```

```
fx1p(2) = -4.7*x1p(2)-1.55*x2p(2)-0.55*x3p(2)+u(2);  
fx2p(2) = 0.3*x1p(2)-2.75*x2p(2)-0.35*x3p(2);  
fx3p(2) = 1.1*x1p(2)+1.85*x2p(2)-2.55*x3p(2)-u(2);
```

```
%Correct
```

```
x1c(2) = 1.56*x1c(1) + stable_acc * (0.46*fx1p(2) + 0.29*fx1p(1));  
x2c(2) = 1.56*x2c(1) + stable_acc * (0.46*fx2p(2) + 0.29*fx2p(1));  
x3c(2) = 1.56*x3c(1) + stable_acc * (0.46*fx3p(2) + 0.29*fx3p(1));
```

```
fx1c(2) = -4.7*x1c(2)-1.55*x2c(2)-0.55*x3c(2)+u(2);  
fx2c(2) = 0.3*x1c(2)-2.75*x2c(2)-0.35*x3c(2);  
fx3c(2) = 1.1*x1c(2)+1.85*x2c(2)-2.55*x3c(2)-u(2);
```

```
y(2) = 2*x1c(2)+x2c(2)+x3c(2);
```

```
for k = 3:N-2
```

```
%Predict
```

```
x1p(k) = 1.45*x1c(k-1) - 0.45*x1c(k-2) + stable_acc * (1.27*fx1c(k-1) - 0.73*fx1c(k-2));  
x2p(k) = 1.45*x2c(k-1) - 0.45*x2c(k-2) + stable_acc * (1.27*fx2c(k-1) - 0.73*fx2c(k-2));  
x3p(k) = 1.45*x3c(k-1) - 0.45*x3c(k-2) + stable_acc * (1.27*fx3c(k-1) - 0.73*fx3c(k-2));
```

```
fx1p(k) = -4.7*x1p(k)-1.55*x2p(k)-0.55*x3p(k)+u(k);  
fx2p(k) = 0.3*x1p(k)-2.75*x2p(k)-0.35*x3p(k);  
fx3p(k) = 1.1*x1p(k)+1.85*x2p(k)-2.55*x3p(k)-u(k);
```

```

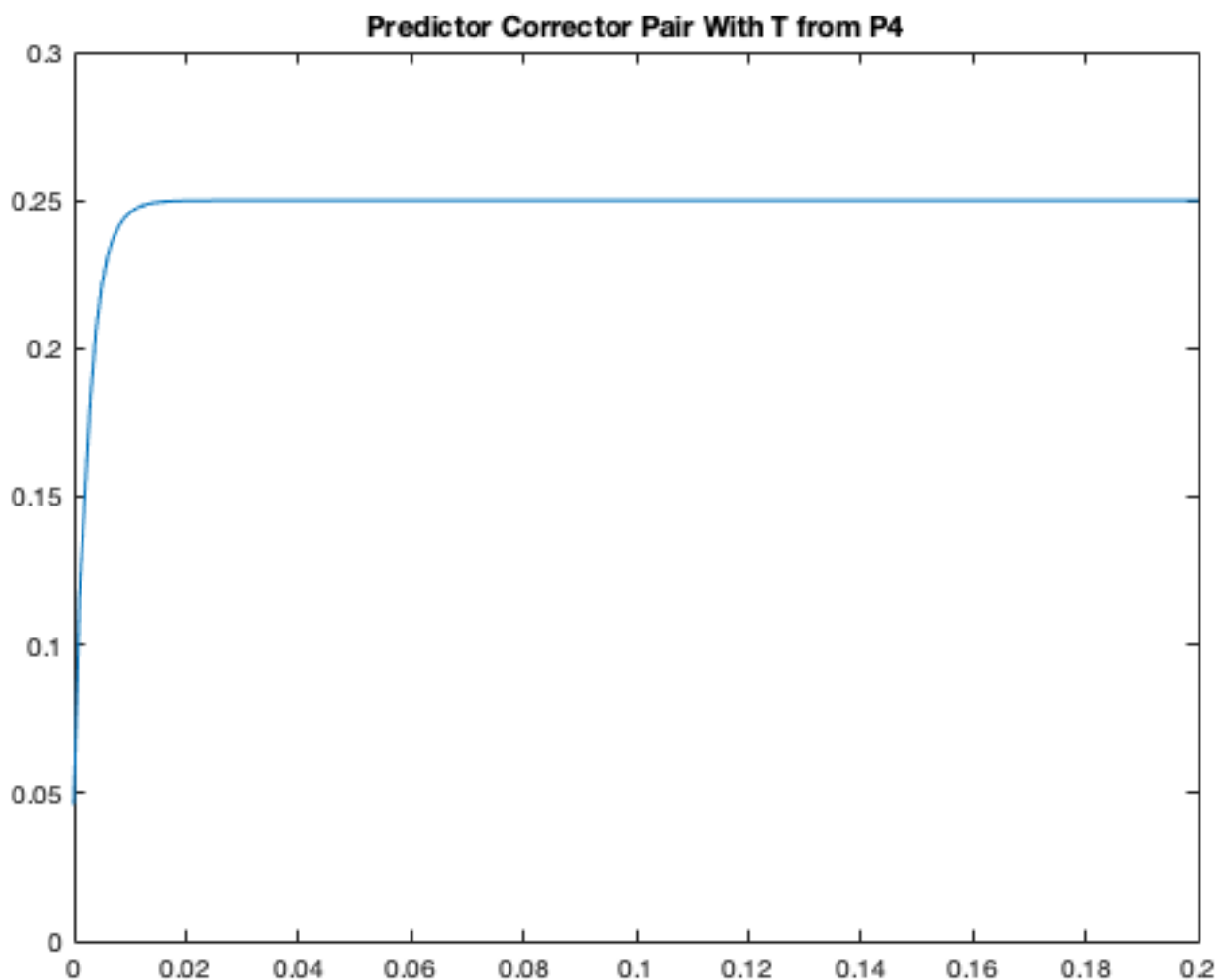
%Correct
x1c(k) = 1.56*x1c(k-1) - 0.56*x1c(k-2) + stable_acc * (0.46*fx1p(k) + 0.29*fx1p(k-1) - 0.3
2*fx1p(k-2));
x2c(k) = 1.56*x2c(k-1) - 0.56*x2c(k-2) + stable_acc * (0.46*fx2p(k) + 0.29*fx2p(k-1) - 0.3
2*fx2p(k-2));
x3c(k) = 1.56*x3c(k-1) - 0.56*x3c(k-2) + stable_acc * (0.46*fx3p(k) + 0.29*fx3p(k-1) - 0.3
2*fx3p(k-2));

fx1c(k) = -4.7*x1c(k)-1.55*x2c(k)-0.55*x3c(k)+u(k);
fx2c(k) = 0.3*x1c(k)-2.75*x2c(k)-0.35*x3c(k);
fx3c(k) = 1.1*x1c(k)+1.85*x2c(k)-2.55*x3c(k)-u(k);

y(k) = 2*x1c(k)+x2c(k)+x3c(k);
end

figure
plot(t,y)
xlim([0 0.2])
title('Predictor Corrector Pair With T from P4')

```



PART C

```

disp('The plots for Part A and Part B are similiar')
disp('This is because the T value for PART A is both stable and accurate for the predictor and
corrector')
disp('while the T value for PART B is stable and accurate for the correct, but less stable and

```

```

accurate for the predictor')
disp('This is because the stability region for the corrector is much larger and encompasses th
at of the corrector')
disp('Meaning that values that look to be stable and accurate for the corrector are not necess
ilarily acceptable for the predictor')

disp('This effect is exaggerated in Figure 3 where a stable and accurate value for the correct
or is chosen that is unstable for the predictor')

N = 10000;
t = linspace(0,10,N);
u = ones(1,N);
stable_acc = 0.4280; %Stable for corrector, but not predictor

fx1c = zeros(1,N);
fx2c = zeros(1,N);
fx3c = zeros(1,N);

x1p = zeros(1,N);
x2p = zeros(1,N);
x3p = zeros(1,N);

fx1p = zeros(1,N);
fx2p = zeros(1,N);
fx3p = zeros(1,N);

x1c = zeros(1,N);
x2c = zeros(1,N);
x3c = zeros(1,N);
y = zeros(1,N);

%Predict
x1p(1) = 0;
x2p(1) = 0;
x3p(1) = 0;

fx1p(1) = -4.7*x1p(1)-1.55*x2p(1)-0.55*x3p(1)+u(1);
fx2p(1) = 0.3*x1p(1)-2.75*x2p(1)-0.35*x3p(1);
fx3p(1) = 1.1*x1p(1)+1.85*x2p(1)-2.55*x3p(1)-u(1);

%Correct
x1c(1) = stable_acc * (0.46*fx1p(1));
x2c(1) = stable_acc * (0.46*fx2p(1));
x3c(1) = stable_acc * (0.46*fx3p(1));

fx1c(1) = -4.7*x1c(1)-1.55*x2c(1)-0.55*x3c(1)+u(1);
fx2c(1) = 0.3*x1c(1)-2.75*x2c(1)-0.35*x3c(1);
fx3c(1) = 1.1*x1c(1)+1.85*x2c(1)-2.55*x3c(1)-u(1);

y(1) = 2*x1c(1)+x2c(1)+x3c(1);

%Predict
x1p(2) = 1.45*x1c(1) + stable_acc * (1.27*fx1c(1));
x2p(2) = 1.45*x2c(1) + stable_acc * (1.27*fx2c(1));

```

```

x3p(2) = 1.45*x3c(1) + stable_acc * (1.27*fx3c(1));

fx1p(2) = -4.7*x1p(2)-1.55*x2p(2)-0.55*x3p(2)+u(2);
fx2p(2) = 0.3*x1p(2)-2.75*x2p(2)-0.35*x3p(2);
fx3p(2) = 1.1*x1p(2)+1.85*x2p(2)-2.55*x3p(2)-u(2);

%Correct
x1c(2) = 1.56*x1c(1) - 0.56*x1c(k) + stable_acc * (0.46*fx1p(2) + 0.29*fx1p(1));
x2c(2) = 1.56*x2c(1) - 0.56*x2c(k) + stable_acc * (0.46*fx2p(2) + 0.29*fx2p(1));
x3c(2) = 1.56*x3c(1) - 0.56*x3c(k) + stable_acc * (0.46*fx3p(2) + 0.29*fx3p(1));

fx1c(2) = -4.7*x1c(2)-1.55*x2c(2)-0.55*x3c(2)+u(2);
fx2c(2) = 0.3*x1c(2)-2.75*x2c(2)-0.35*x3c(2);
fx3c(2) = 1.1*x1c(2)+1.85*x2c(2)-2.55*x3c(2)-u(2);

y(2) = 2*x1c(2)+x2c(2)+x3c(2);

for k = 3:N-2

    %Predict
    x1p(k) = 1.45*x1c(k-1) - 0.45*x1c(k-2) + stable_acc * (1.27*fx1c(k-1) - 0.73*fx1c(k-2));
    x2p(k) = 1.45*x2c(k-1) - 0.45*x2c(k-2) + stable_acc * (1.27*fx2c(k-1) - 0.73*fx2c(k-2));
    x3p(k) = 1.45*x3c(k-1) - 0.45*x3c(k-2) + stable_acc * (1.27*fx3c(k-1) - 0.73*fx3c(k-2));

    fx1p(k) = -4.7*x1p(k)-1.55*x2p(k)-0.55*x3p(k)+u(k);
    fx2p(k) = 0.3*x1p(k)-2.75*x2p(k)-0.35*x3p(k);
    fx3p(k) = 1.1*x1p(k)+1.85*x2p(k)-2.55*x3p(k)-u(k);

    %Correct
    x1c(k) = 1.56*x1c(k-1) - 0.56*x1c(k-2) + stable_acc * (0.46*fx1p(k) + 0.29*fx1p(k-1) - 0.3
2*fx1p(k-2));
    x2c(k) = 1.56*x2c(k-1) - 0.56*x2c(k-2) + stable_acc * (0.46*fx2p(k) + 0.29*fx2p(k-1) - 0.3
2*fx2p(k-2));
    x3c(k) = 1.56*x3c(k-1) - 0.56*x3c(k-2) + stable_acc * (0.46*fx3p(k) + 0.29*fx3p(k-1) - 0.3
2*fx3p(k-2));

    fx1c(k) = -4.7*x1c(k)-1.55*x2c(k)-0.55*x3c(k)+u(k);
    fx2c(k) = 0.3*x1c(k)-2.75*x2c(k)-0.35*x3c(k);
    fx3c(k) = 1.1*x1c(k)+1.85*x2c(k)-2.55*x3c(k)-u(k);

    y(k) = 2*x1c(k)+x2c(k)+x3c(k);
end

figure
plot(t,y)
xlim([0 0.2])
title('Stable Corrector & Unstable predictor')

```

The plots for Part A and Part B are similiar

This is because the T value for PART A is both stable and accurate for the predictor and corre
ctor

while the T value for PART B is stable and accurate for the correct, but less stable and accur

ate for the predictor

This is because the stability region for the corrector is much larger and encompasses that of the corrector

Meaning that values that look to be stable and accurate for the corrector are not necessarily acceptable for the predictor

This effect is exaggerated in Figure 3 where a stable and accurate value for the corrector is chosen that is unstable for the predictor

