```
%--------------------------------------------------------------------------
%
%          ADJUSTMENT THEORY I
%   Exercise 5: Propagation of observation errors - part III
%
%   Author          : Anastasia Pasioti
%   Version         : October 08, 2018
%   Last changes    : November 30, 2022
%
%--------------------------------------------------------------------------
% Group 6
%
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% Corban Rosenauer / 0494441
% Zilong Liu / 0501297
%--------------------------------------------------------------------------

clc;
clear all;
close all;

%--------------------------------------------------------------------------
%   Task 1
%--------------------------------------------------------------------------
disp('Task 1')
```

```
Task 1
```

```

%Given
s1 = 824.62;                    %[m]
s2 = 1026.98;                   %[m]
s3 = 802.00;                    %[m]
a1 = 68.3582*pi/200;            %[gon]->[rad]
a2 = 52.9212*pi/200;            %[gon]->[rad]

ms1 = 0.012;                    %[cm]->[m]
ms2 = 0.019;                    %[cm]->[m]
ms3 = 0.036;                    %[cm]->[m]
ma1 = 0.0015*pi/200;            %[mgon]->[gon]->[rad]
ma2 = 0.0041*pi/200;            %[mgon]->[gon]->[rad]

%Coordinates of points
x2 = s2 - s3 * cos(a2);
y2 = s3 * sin(a2);
x4 = s1 * cos(a1);                          %[m]
y4 = -s1 * sin(a1);                          %[m]
```

```
%Distance between point 2 and 4
s24 = sqrt((x2-x4)^2+(y2-y4)^2);  %[m]



%Design matrices
F1 = [0 1 -cos(a2) 0 s3*sin(a1);
    0 0 sin(a2) 0 s3*cos(a2);
    cos(a1) 0 0 -s1*sin(a1) 0;
    -sin(a1) 0 0 -s1*cos(a1) 0];

F2 = [(x2-x4)/s24 (y2-y4)/s24 -(x2-x4)/s24 -(y2-y4)/s24];

F = F2*F1;

%Stochastic model
S_LL = diag([ms1^2,ms2^2,ms3^2,ma1^2,ma2^2]);

%VC propagation
S_XX = F*S_LL*F';

%Standard deviation
s_s24 = sqrt(S_XX);   %[m]

disp(['s = ' num2str(s24) ' m'])
```

```
s = 1320.6591 m
```

```
disp(['s_s = ' num2str(s_s24) ' m'])
```

```
s_s = 0.047622 m
```

2.1

```
%--------------------------------------------------------------------------
%   Task 2
%--------------------------------------------------------------------------

%Given
a1 = 35.1550*pi/200; %[gon]->[rad]
a2 = 55.1200*pi/200; %[gon]->[rad]
s1 = 20.005; %[m]
s2 = 30.001; %[m]
t1 = 9.7; %[s]
t2 = 23.1; %[s]
t3 = 30.0; %[s]

s_a = 0.001*pi/200; %[gon]->[rad]
s_s = 0.001; %[m]
```

```
s_t = 0.1; %[s]

%Task 2.1. Velocity.
disp('Task 2.1')
```

```
Task 2.1
```

```
%Coordinates of points
x1 = s1*sin(a1); %[m]
y1 = s1*cos(a1); %[m]
x2 = s2*sin(a2); %[m]
y2 = s2*cos(a2); %[m]

%Distance between points 1 and 2
s12 = sqrt((x1-x2)^2+(y1-y2)^2);  %[m]

%Constant velocity of the car
v = s12/(t2-t1); %[m/s]

%Design matrices
F1=[1 0 0 0 0 0;
    0 1 0 0 0 0;
    0 0 sin(a1) 0 s1*cos(a1) 0;
    0 0 cos(a1) 0 -s1*sin(a1) 0;
    0 0 0 sin(a2) 0 s1*cos(a2);
    0 0 0 cos(a2) 0 -s1*sin(a2)];

F2=[1 0 0 0 0 0;
    0 1 0 0 0 0;
    0 0 (x1-x2)/s12 (y1-y2)/s12 -(x1-x2)/s12 -(y1-y2)/s12];

F3=[s12/(t2-t1)^2 -s12/(t2-t1)^2 1/(t2-t1)];

F = F3*F2*F1;

%Stochastic model
S_LL=diag([s_t^2 s_t^2 s_s^2 s_s^2 s_a^2 s_a^2]);

%VC propagation
S_XX = F*S_LL*F';

%Standard deviation
s_v = sqrt(S_XX);   %[m]

disp(['v = ' num2str(v) ' m/s'])
```

```
v = 0.93942 m/s
```

```
disp(['s_v = ' num2str(s_v) ' m/s'])
```

```
s_v = 0.0099149 m/s
```

```
%Task 2.2. Coordinates.
disp('Task 2.2')
```

```
Task 2.2
```

```
%Equations realting time with coordinates
syms a_1 b_1 a_2 b_2 x_1 y_1 x_2 y_2 t_1 t_2 x_3 y_3

eq1 = a_1 * t_1 + b_1 == x_1;
eq2 = a_1 * t_2 + b_1 == x_2;
sol1 = solve([eq1 eq2], [a_1 b_1]);
A = subs(sol1,{x_1,x_2,t_1,t_2},{x1,x2,t1,t2});
a_1 = A.a_1;
b_1 = A.b_1;


eq1 = a_2 * t_1 + b_2 == y_1;
eq2 = a_2 * t_2 + b_2 == y_2;
sol2 = solve([eq1 eq2], [a_2 b_2]);
A = subs(sol2,{y_1,y_2,t_1,t_2},{y1,y2,t1,t2});
a_2 = A.a_2;
b_2 = A.b_2;


%Coordinates of point 3
x_3 = sol1.a_1 * t3 + sol1.b_1;
y_3 = sol2.a_2 * t3 + sol2.b_2;

x3 = round(a_1 * t3 + b_1, 3);
y3 = round(a_2 * t3 + b_2, 3);

%Design matrices

F1=[sin(a1) 0       s1*cos(a1)  0           0 0;
    cos(a1) 0       -s1*sin(a1) 0           0 0;
    0       sin(a2) 0           s1*cos(a2)  0 0;
    0       cos(a2) 0           -s1*sin(a2) 0 0;
    0       0       0           0           1 0;
    0       0       0           0           0 1];


F2 =[diff(x_3, x_1) diff(x_3, y_1) diff(x_3, x_2) diff(x_3, y_2) diff(x_3, t_1)
diff(x_3, t_2);
    diff(y_3, x_1) diff(y_3, y_1) diff(y_3, x_2) diff(y_3, y_2) diff(y_3, t_1)
diff(y_3, t_2)];

F2 = eval(subs(F2,{x_1,y_1,x_2,y_2,t_1,t_2},{x1,y1,x2,y2,t1,t2}));
```

```
F = F2*F1;


%Stochastic model
S_LL=diag([s_s^2 s_s^2 s_a^2 s_a^2 s_t^2 s_t^2]);

%VC propagation
S_XX = F*S_LL*F';

%Standard deviation
s_c = sqrt(S_XX);   %[m]

disp(['x3 = ' char(x3) ' m'; 'y3 = ' char(y3) ' m'])
```

```
x3 = 29.212 m
y3 = 20.682 m
```

```
disp(['s_x3 = ' num2str(s_c(1,1)) ' m'])
```

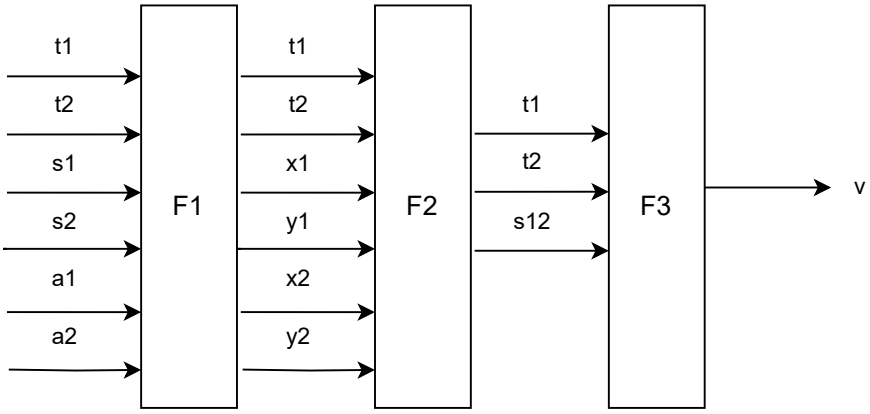
5.1

```
s_x3 = 0.14754 m
```

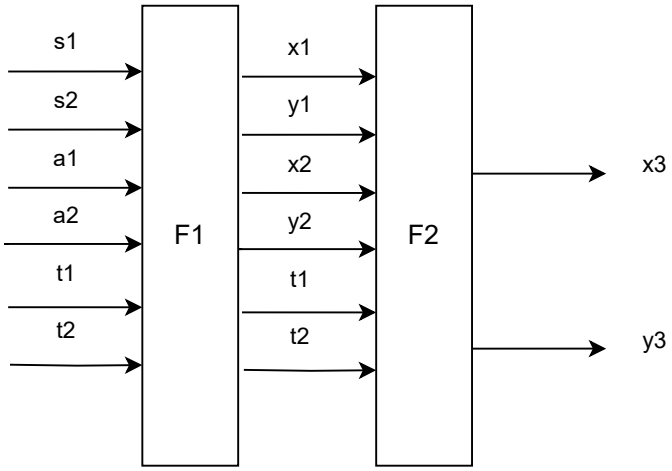
```
disp(['s_y3 = ' num2str(s_c(2,2)) ' m'])
```

```
s_y3 = 0.028793 m
```

Task 2.1



Task 2.2



Index of comments

2.1 s_s24=0.0448235059

5.1 The correct results are

sx3 =0.173981375635917
sy3 =0.0339491569402601