```
%-------------------------------------------------------------------------
%
%          ADJUSTMENT THEORY I
%   Exercise 4: Propagation of observation errors - part II
%
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%   Version         : October 05, 2018
%   Last changes    : November 23, 2022
%
%-------------------------------------------------------------------------
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%-------------------------------------------------------------------------

clc;
clear all;
close all;

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

```
Task 1
```

```
%Given
a = 3;           %[m]
b = 4;           %[m]
c = 5;           %[m]

s_abc = 0.02;    %[m]

%Semiperimeter of the triangle
s = (a+b+c)/2;    %[m]

%Area of the triangle
A = sqrt(s*(s-a)*(s-b)*(s-c))       %[m^2]
```

```
A =
     6
```

```
%Functional relationship
ap = s - a;
```

```
bp = s - b;
cp = s - c;

A_2 = s*ap*bp*cp;

%Design matrices

F1 = [1 0 0; 0 1 0; 0 0 1; 1/2 1/2 1/2];

F2 = [-1 0 0 1; 0 -1 0 1; 0 0 -1 1; 0 0 0 1];

F3 = [s*bp*cp s*ap*cp s*ap*bp ap*bp*cp];

F4 = [1/2*1/sqrt(A_2)];

F=F4*F3*F2*F1
```

```
F = 1×3
          2          1.5            0
```

```

%F =

%Stochastic model
S_LL = s_abc^2*eye(3);

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

%Standard deviation
s_a = sqrt(S_A)
```

```
s_a =
       0.05
```

```
%-------------------------------------------------------------------------------
%   Task 2
%-------------------------------------------------------------------------------
disp('Task 2')
```

```
Task 2
```

```

%Given
s1 = 8;             %[m]
s2 = 6;             %[m]
t1 = 0*pi/200;      %[gon]->[rad]
t2 = 100*pi/200;    %[gon]->[rad]

s_s = 0.001;        %[m]
s_t = 0.1*pi/200;   %[gon]->[rad]
```

```
%Functional relationships
x1 = s1 * cos(t1);
y1 = s1 * sin(t1);
x2 = s2 * cos(t2);
y2 = s2 * sin(t2);

dX = x2 - x1;
dY = y2 - y1;

d_2= dX^2 + dY^2;

d = sqrt(d_2);

disp(['Distance between two points: ' num2str(d) ' m'])
```

```
Distance between two points: 10 m
```

```
%Design matrices
F1=[cos(t1) -s1*sin(t1) 0 0;
    sin(t1) s1*cos(t1) 0 0;
    0 0 cos(t2) -s2*sin(t2);
    0 0 sin(t2) s2*cos(t2)];

F2=[-1 0 1 0;
    0 -1 0 1];

F3=[2*dX 2*dY];

F4=[1/(2*sqrt(d_2))];

F = F4*F3*F2*F1
```

```
F = 1×4
        0.8        -4.8         0.6         4.8
```

```
%Stochastic model
S_LL=[s_s^2 0 0 0;
    0 s_t^2 0 0;
    0 0 s_s^2 0;
    0 0 0 s_t^2];

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

%Standard deviation
s_x = sqrt(S_XX);      %[m]
disp(['Standard deviation of distance: ' num2str(s_x) ' m'])
```

```
Standard deviation of distance: 0.01071 m
```

```
%%-------------------------------------------------------------------------
%   Task 3
%------------------------------------------------------------------------
disp('Task 3')
```

```
Task 3
```

```

%Given
r1 = 10;     %[m]
r2 = 14;     %[m]
H1 = 8;      %[m]
H2 = 12;     %[m]

srH = 0.01;  %[m]

%Functional relationships
a = r1^2*H1+r2^2*H2;
b = r1^2+r2^2;
H = a / b;

%Amount of water at each water tank
V1s = pi*r1^2*H;
V2s = pi*r2^2*H;

%Design matrices

F1=[1 0 0 0;                     %columns: r1 r2 H1 H2 rows: r1 r2 a b
    0 1 0 0;
    2*r1*H1 2*r2*H2 r1^2 r2^2;
    2*r1 2*r2 0 0];

F2=[1 0 0 0;
    0 1 0 0;
    0 0 1/b -a/(b^2)];             %columns: r1 r2 a b rows: r1 r2 H

F3=[2*pi*r1*H 0 pi*r1^2;
    0 2*pi*r2*H pi*r2^2];          %columns: r1 r2 H rows: V1s V2s

F=F3*F2*F1
```

```
F = 2×4
      612.85      40.159      106.13      208.02
      -110.2      1015.4      208.02      407.73
```

```

%Stochastic model
S_LL = srH^2*eye(4);

%VC propagation
```

```
S_XX = F*S_LL*F';

%Standard deviation
s_x = sqrt(S_XX)
```

```
s_x = 2×2
       6.5707       2.8309
       2.8309       11.193
```

```
disp(['Final volume of water in the 1st tank: ' num2str(V1s) ' m3';'Final volume of water in the 2nd tank: ' num2str(V2s) ' m3']);
```

```
Final volume of water in the 1st tank: 3345.3716 m3
Final volume of water in the 2nd tank: 6556.9284 m3
```

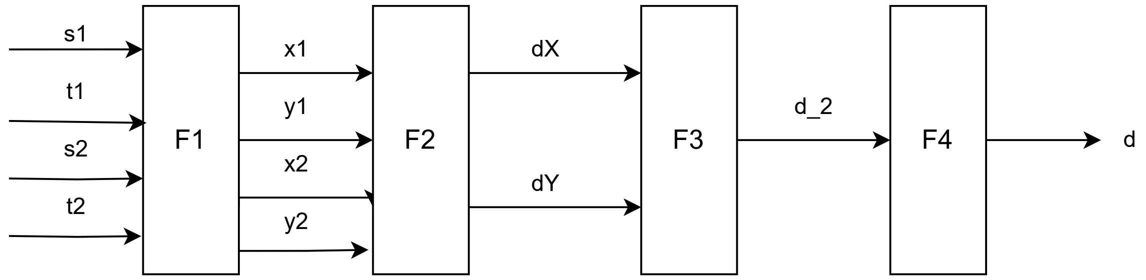
```
disp(['SD of V1s: ' num2str(s_x(1,1)) ' m3'])
```

```
SD of V1s: 6.5707 m3
```

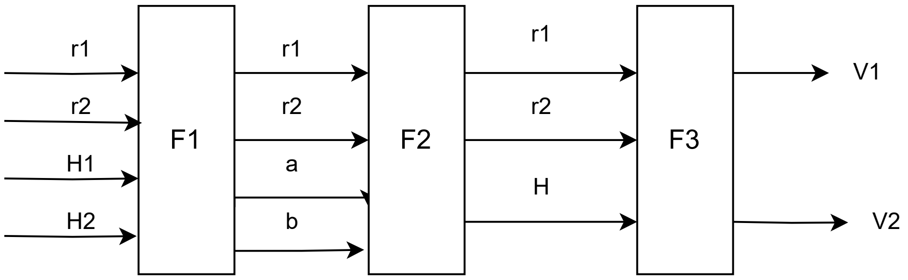
```
disp(['SD of V2s: ' num2str(s_x(2,2)) ' m3'])
```

```
SD of V2s: 11.1925 m3
```

Task 2


s1
t1
s2
t2
F1
x1
y1
x2
y2
F2
dX
dY
F3
d_2
F4
d

Task 3


r1
r2
H1
H2
F1
r1
r2
a
b
F2
r1
r2
H
F3
V1
V2