Assignment 4: Implement a Filter
Seth Kurtenbach

Description: In this assignment, I use data from A3-MeasurementData.bin to implement a filter, estimating 3D coordinates as measured by the sensor.

Deliverables:

1. First observation mean vector z and sqrt of its covariance R.

$$z1 = \begin{bmatrix} 12.7785 \\ 130.0927 \\ 23.5293 \end{bmatrix}$$

$$sqrtm(R) = \begin{bmatrix} .87112 & .38768 & .30142 \\ .38768 & 1.17254 & .68910 \\ .30142 & .68910 & 1.56022 \end{bmatrix}$$

However, in initializing my filter, I used the following initial input:

$$z0 = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$sqrtm(R) = \begin{bmatrix} 10^5 & 0 & 0 \\ 0 & 10^5 & 0 \\ 0 & 0 & 10^5 \end{bmatrix}$$

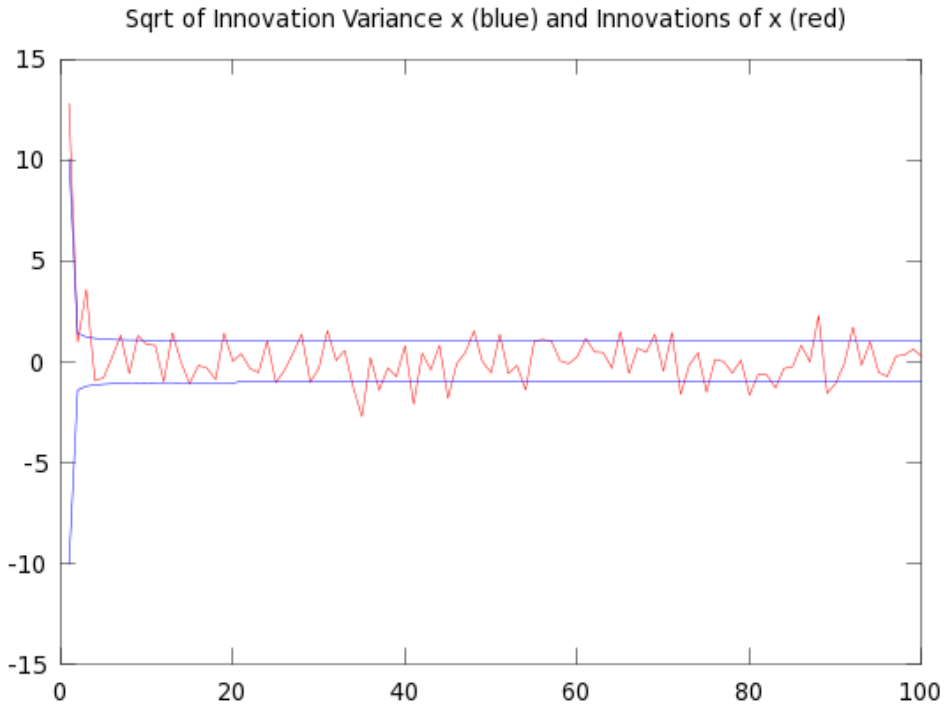
in order to represent an initial state of complete uncertainty.

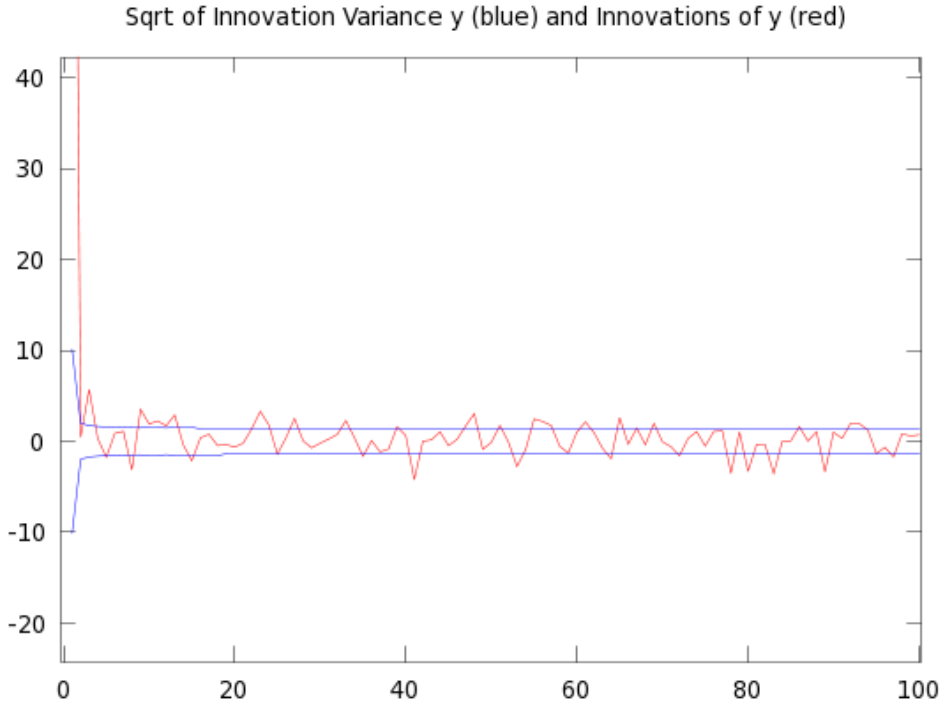
2. Final mean x and sqrt of covariance matrix P.

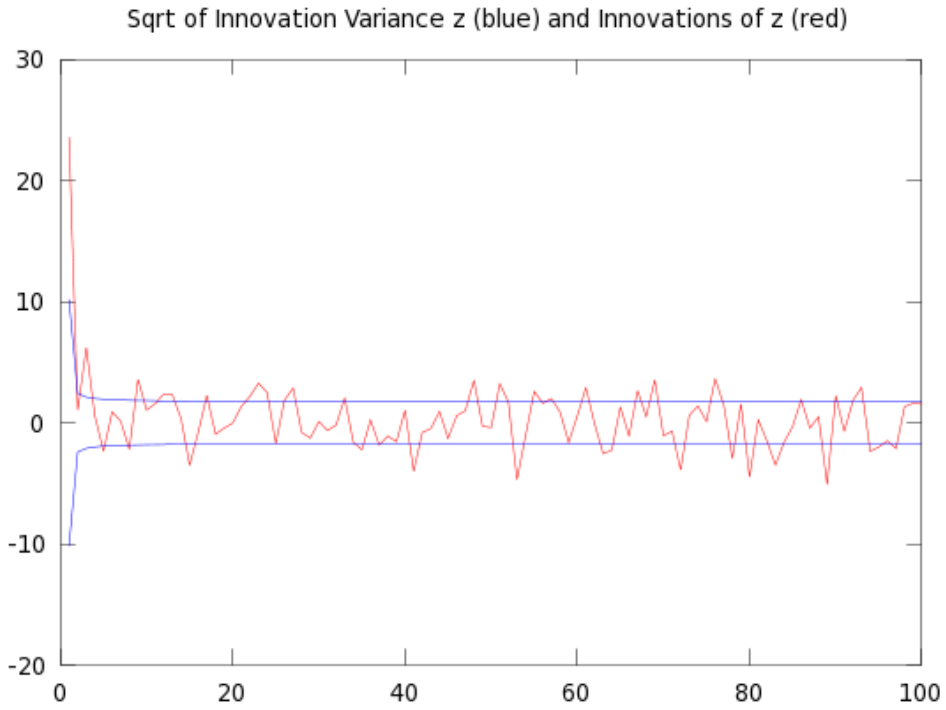
$$x = \begin{bmatrix} 12.896 \\ 130.398 \\ 23.495 \end{bmatrix}$$

$$sqrtm(P) = \begin{bmatrix} .0027547 & .0012260 & .000953160 \\ .001226 & .0037079 & .0021791 \\ .00095316 & .0021791 & .0049339 \end{bmatrix}$$

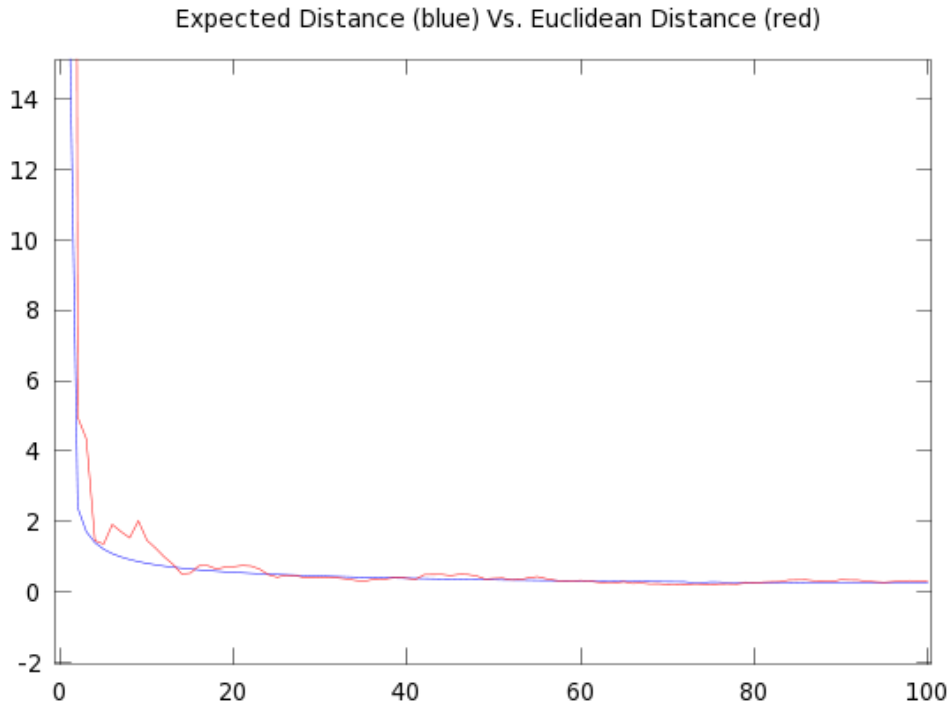
3. Three plots showing innovations in x,y,z with sqrts of respective invariances.


Sqrt of Innovation Variance x (blue) and Innovations of x (red)
15
10
5
0
-5
-10
-15
0
20
40
60
80
100


Sqrt of Innovation Variance y (blue) and Innovations of y (red)
40
30
20
10
0
-10
-20
0
20
40
60
80
100



4. Plot of Expected distance (blue) vs Euclidean distance (red)



Code

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# Assignment 4: Implement a filter to process 3D sensor observations.
# Seth Kurtenbach

actual = [12.9; 130.4; 23.5];

R = [1,1,1;
     1,2,2;
     1,2,3];

fm = fopen("A3-MeasurementData(1).bin");

meas = fread(fm, [3, 100000], "float");

## Initialized Estimate (x, P) ##
x = [0;0;0];

P = [10^10,0,0;
     0,10^10,0;
     0,0,10^10];

for i = 1:100000
    z = [meas(1,i);meas(2,i);meas(3,i)];
    S = P + R;
    W = P * inv(S);

    innovX(i) = z(1) – x(1);
    innVarX(i) = sqrt(S(1,1));
    innVarXmin(i) = -(innVarX(i));

    innovY(i) = z(2) - x(2);
    innVarY(i) = sqrt(S(2,2));
    innVarYmin(i) = - (innVarY(i));

    innovZ(i) = z(3) - x(3);
    innVarZ(i) = sqrt(S(3,3));
    innVarZmin(i) = - (innVarZ(i));

    euc(i) = norm(x - actual, 2);
    expDist(i) = sqrt(sum(eig(P)));

    P = P - (W * S * W');
    x = x + (W * (z - x));

end
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