**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.

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

$$sqrt(R) = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1.4142 & 1.4142 \\ 1 & 1.4142 & 1.7321 \end{bmatrix}$$

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

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

$$sqrt(R) = \begin{bmatrix} 10 & 0 & 0 \\ 0 & 10 & 0 \\ 0 & 0 & 10 \end{bmatrix}$$

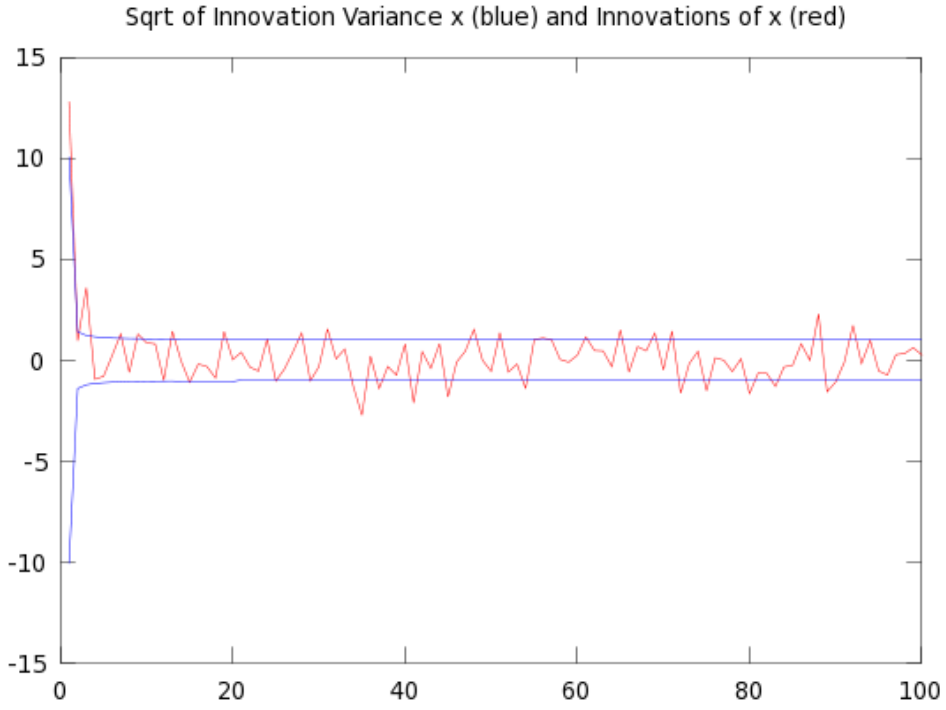
in order to represent an initial state of complete uncertainty.

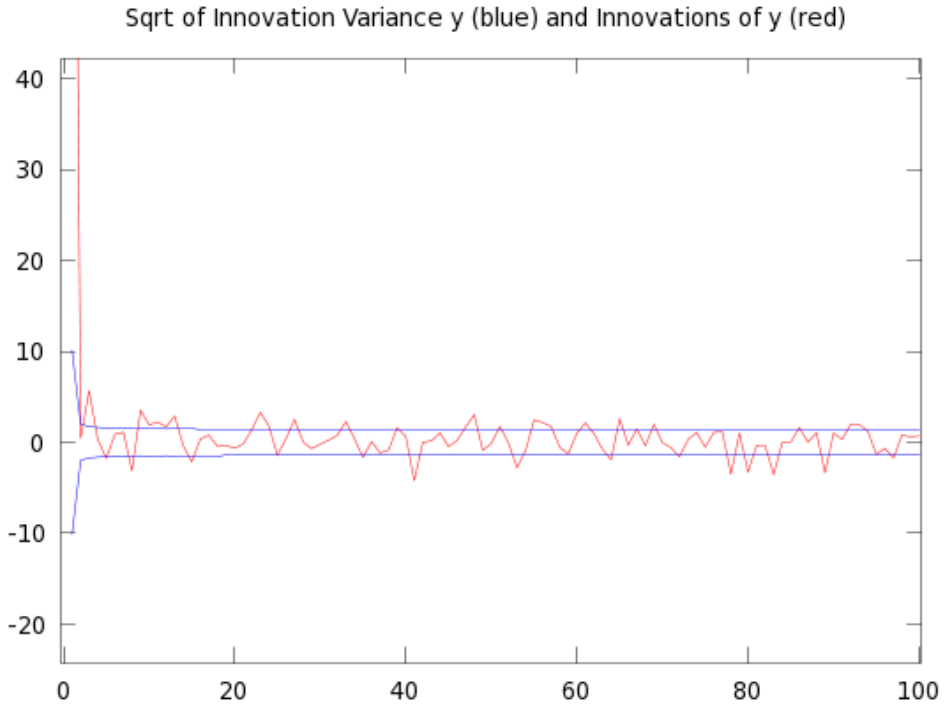
2. Final mean x and sqrt of covariance matrix P.

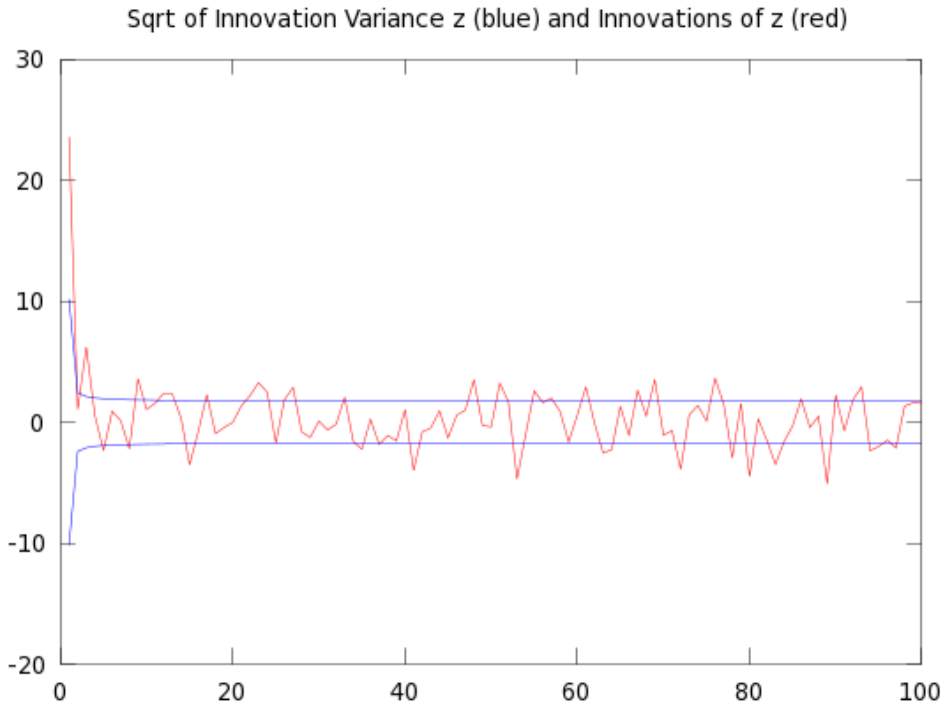
$$x = \begin{bmatrix} 12.896 \\ 130.398 \\ 23.495 \end{bmatrix}$$

$$sqrtm(P) = \begin{bmatrix} .0025747 & .0012260 & .000953160 \\ .001226 & .0037079 & .0021791 \\ .00095316 & .0021791 & .0049338 \end{bmatrix}$$

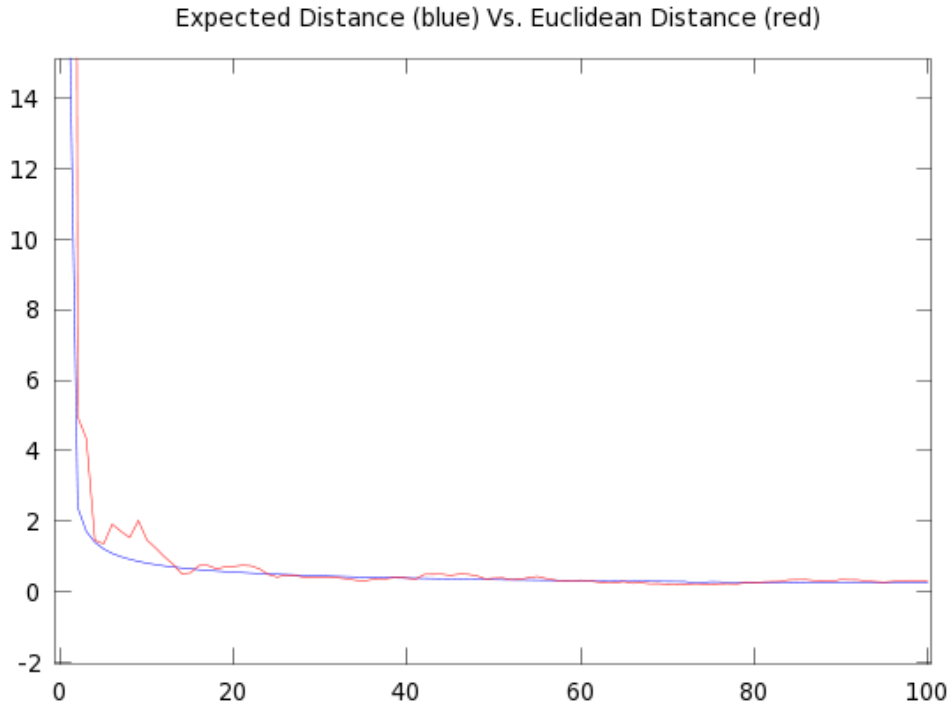
3. Three plots showing innovations in x,y,z with sqrts of respective invariances.






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 = [100,0,0;
     0,100,0;
     0,0,100];

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));

   #newX(1) = x(1,1);
   #newX(2) = x(2,2);
   #newX(3) = x(3,3);

         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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