

Part A:

A.1:

For this project we used 5 different formulas, two constants, Q and R for noise values, and 3 Identity matrices, A B and H. The two Predict formulas end up being used in the Update formulas later on. Therefore in a loop, the only variables would be $X_{k|k-1}$ and $P_{k|k-1}$ both of which are the previous iterations' position values. Initially, we set X to [0,0] and P to an identity matrix. Once the new update values are calculated, we store them and the next iteration will call upon those values.

A priori : Predict

① Predicted State Estimate: $X_{k|k-1} = A \cdot X_{k|k-1} + B \cdot u_k$ * Wiki: uses F instead.

② Predicted Error Covariance: $P_{k|k-1} = A \cdot P_{k-1|k-1} \cdot A^T + Q_k$ from Noise

A posteriori : Update

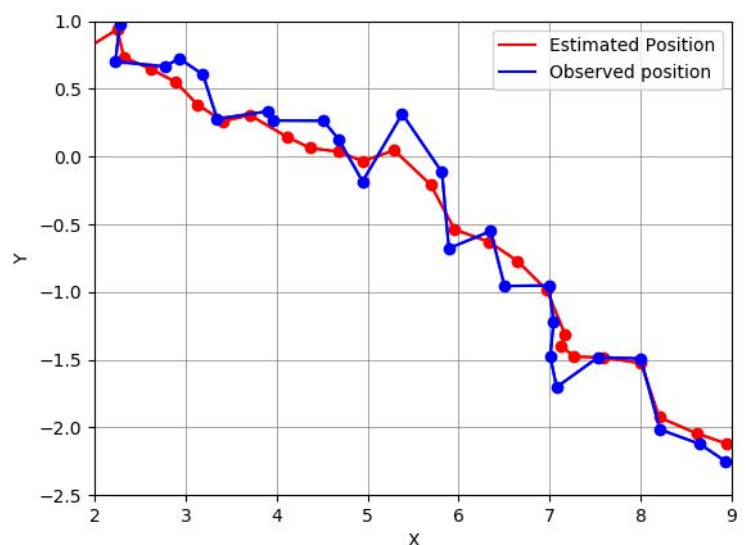
③ Optimal Kalman Gain: $K_k = P_{k|k-1} \cdot H_k^T \cdot S_k^{-1}$
 $= (A \cdot P_{k-1|k-1} \cdot A^T + Q_k) \cdot H_k^T \cdot S_k^{-1}$ $S_k = R_k + H_k \cdot P_{k|k-1} \cdot H_k^T$

④ Updated State estimate: $X_{k|k} = X_{k|k-1} + K_k \cdot y_k$ $y_k = Z_k - H_k \cdot X_{k|k-1}$

⑤ Updated Estimate Covariance: $P_{k|k} = (I - K_k \cdot H_k) \cdot P_{k|k-1} \cdot (I - K_k \cdot H_k)^T + K_k R_k K_k^T$

A.4

We decided to use Lambda = 1 for the project. Using Lambda < 1 caused the estimated position values to be way off target, and greater than 1 was more stable, but still off point in a small fractional value.



B.2

Our prediction algorithm calculates based on the observed position minus the estimated position, and to get an accurate result, we had to tighten the range to within 4.5 units of each other. To test, we ran our program 100 times each in different tightness. Ex: Abs 5 represents where the final difference is no greater than 5. Based on our calculations, 4.5 seems to give the best average results among the few.

E	F	G	H	I	J	K	L	M	N	O
-0.01517		abs 5		0.213161		abs 4		-0.32134	abs 3	
-1.07642				-0.63603				-0.32646		
-3.20728	average =	-1.31101		-5.05153	average =	-1.63053		-0.19618	average =	-1.71225
-2.22458	Max	7.322692		-1.93091	Max	4.834001		0.521765	Max	4.304236
3.037006	Min	-11.3709		-2.68113	Min	-12.5388		-2.6312	Min	-8.66641
-4.34706	Total	100		-0.65127	Total	100		-2.32698	Total	100
-0.69926				4.834001				0.746485		
1.49179	over 6	7		-0.98585	over 6	4		-1.44866	over 6	7
-2.29585				-2.396				2.039232		

Q	R	S
-1.61209		abs 4.5
-0.94891		
-2.96769	average =	-1.20545
-0.17462	Max	3.139179
-2.36497	Min	-8.08931
-1.92835	Total	100
-0.44874		
-2.12906	over 6	2
-1.22005		