HW5 Problem 6

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AOE 5784

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Results:

HW5-P6

50 Monte Carlo's:

P_obs_10 =

```
  0.001685037889159  -0.001960890248705
  -0.001960890248705   0.132750322569187
```

xtil_mu_10 =

```
  0.009836097018543   0.002413490133935
```

P_est_10 =

```
  0.001684356805503   0.000851637905493
  0.000851637905493   0.089420255095101
```

P_obs_35 =

```
  0.001604954483244   0.000929190452452
  0.000929190452452   0.061380608944991
```

xtil_mu_35 =

```
  -0.001730036769037  -0.082745748260370
```

P_est_35 =

```
  0.001622216524173   0.000662325081077
  0.000662325081077   0.084545653745850
```

1000 Monte Carlo's:

P_obs_10 =

```
  0.001780496800946   0.000613055000826
  0.000613055000826   0.092962887993726
```

xtil_mu_10 =

```
  -0.000920179678361  -0.015401560401631
```

P_est_10 =

```
  0.001684356805503   0.000851637905493
  0.000851637905493   0.089420255095101


P_obs_35 =

  0.001595398953031   0.000386304340128
  0.000386304340128   0.085142434109844


xtil_mu_35 =

  0.000752078684707   0.016454329553106


P_est_35 =

  0.001622216524173   0.000662325081077
  0.000662325081077   0.084545653745850
```

Code:

```
%% Implement a Kalman filter for the example problem that was presented in class
% Spencer Freeman, 11/20/2024
% AOE 5784, Estimation and Filtering
%
% This script solves number 6 of problem set 5
% ------------------------------------------------------------------------
clear;clc;close all

disp('HW5-P6')

format long

%% P3
kf_example02a % bring in data

% Q(k) = 6 and the new measurement noise covariance R(k) = 0.05.
Qk = 6;
Rk = 0.05;

nx = length(xhat0);
n = length(thist) + 1;

nmc = 50; % monte carlo's

disp(" ")
disp("50 Monte Carlo's:")
[P_obs_10, xtil_mu_10, P_est_10, P_obs_35, xtil_mu_35 P_est_35] = run_mc( ...
   thist, Fk,Gammak,Hk,Qk,Rk,xhat0,P0,n, nx, nmc)

nmc = 1000; % monte carlo's

disp(" ")
disp("1000 Monte Carlo's:")
[P_obs_10, xtil_mu_10, P_est_10, P_obs_35, xtil_mu_35 P_est_35] = run_mc( ...
   thist, Fk,Gammak,Hk,Qk,Rk,xhat0,P0,n, nx, nmc)
```

```
function [P_obs_10, xtil_mu_10, P_est_10, P_obs_35, xtil_mu_35 P_est_35] = run_mc( ...
  thist, Fk,Gammak,Hk,Qk,Rk,xhat0,P0,n, nx, nmc)

xtil = nan(nx, n, nmc); % error for MC's

for j = 1:nmc

[xtruehist,zhist] = kf_truthmodel_midterm(Fk,Gammak,Hk,Qk,Rk,xhat0,P0,n - 1);


t = 0; % s
xhat = xhat0; % initial state estimate
phat = P0; % initial state covariance

ts = nan(1, n);
xhats = nan(nx, n);
phats = nan(nx * nx, n);
for i = 1:(n - 1)

  ts(i) = t;
  xhats(:, i) = xhat;
  phats(:, i) = phat(:); % unwrap to column vector

  t = thist(i); % s
  xbar = Fk * xhat; % propagate state estimate
  pbar = Fk * phat * Fk' + Gammak * Qk * Gammak'; % propagate state covariance

  zbar = Hk * xbar; % expected measurement
  z = zhist(i); % actual measurement
  v = z - zbar; % filter innovation

  S = Hk * pbar * Hk' + Rk; % expected measurement covariance
  W = pbar * Hk' * inv(S); % filter gain

  xhat = xbar + W * v; % updated state estimate
  phat = pbar - W * S * W'; % updates state covariance

end % for

% record the final filter outputs
ts(n) = t;
xhats(:, n) = xhat;
phats(:, n) = phat(:); % unwrap to column vector

xtil(:, :, j) = xtruehist' - xhats;

end % for


xtil_10 = squeeze(xtil(:, 10, :))';
xtil_mu_10 = mean(xtil_10, 1);
% P_obs_10 = cov(xtil_10);

temp = nan(2, 2, nmc);
for i = 1:nmc
  temp(:, :, i) = xtil(:, 10, i) * xtil(:, 10, i)';
end
P_obs_10 = mean(temp, 3);

P_est_10 = reshape(phats(:, 10), size(P0));
```

```
xtil_35 = squeeze(xtil(:, 35, :))';
xtil_mu_35 = mean(xtil_35, 1);
% P_obs_35 = cov(xtil_35);

temp = nan(2, 2, nmc);
for i = 1:nmc
   temp(:, :, i) = xtil(:, 35, i) * xtil(:, 35, i)';
end
P_obs_35 = mean(temp, 3);

P_est_35 = reshape(phats(:, 35), size(P0));

end % function
```