Estimation of a Constant Using a Kalman Filter

Introduction

- Suppose we acquire measurements of a quantity that we know to be **constant**, or at most admits of **step changes**.
- The *observations* we have are affected by *measurement noise* (as usual, the measurement sensor introduces noise into the measurement result).
- How can we use a Kalman filter as an optimal predictor of the (constant) quantity?

The Model

What could be the description in **state equations** of the dynamics of a **variable** that is actually **constant** (thus **NOT varying in time**)?

If we denote by $x(t)$ the state variable at the time instant t, representing the constant to be estimated, the dynamics of this state variable over time is:

$$\begin{cases} x(t+1) &= ? \\ y(t) &= x(t) + v_2(t) \end{cases} \qquad v_2(\cdot) \sim \mathrm{WGN}\left(0, \lambda_2^2\right)$$

The Data

Initialization

```
clear
clc
close all

load L14_Kalman_ConstantEstimationDATA.mat
% y <--> the measurements of the state variable, i.e. the constant to be
%        estimated
% DeltaT <--> the sampling period [s]

N = numel(y); % how many data?
timeSteps = (0:N-1).*DeltaT; % the sampling time instants
```

```
whos
```

```
  Name             Size                Bytes  Class     Attributes

  DeltaT           1x1                     8  double              
  N                1x1                     8  double              
  timeSteps        1x36000            288000  double              
  y                1x36000            288000  double              
```

Plotting the Measurements

```
figure('Units','normalized','Position',[0.1, 0.1, 0.9, 0.75]);

plot(timeSteps, y,'bo-');
grid on; zoom on;
xlim([min(timeSteps), max(timeSteps)]);
xlabel('Time instants $t$ [s]', 'Interpreter','latex','FontSize',12);
ylabel('Meas. of $y(t)$',  'Interpreter','latex','FontSize',12);
```