

JANUARY 2018							FEBRUARY 2018						
Wk	M	T	W	T	F	S	Wk	M	T	W	T	F	S
01	1	2	3	4	5	6	05				1	2	3
02	7	8	9	10	11	12	06	4	5	6	7	8	9
03	13	14	15	16	17	18	07	10	11	12	13	14	15
04	19	20	21	22	23	24	08	16	17	18	19	20	21
05	25	26	27	28	29	30	09	22	23	24	25	26	27
06	31						10	28	29	30			

January

31

WEEK - 5 / DAY (031-334)

WEDNESDAY

Tracking and Estimation of moving object using Kalman filter -

Kalman filter -

state space formulation of linear dynamical systems. provides a recursive solution to the linear optimal filtering.

state space model.

$$x_k = \alpha x_{k-1} + w_k \quad \text{--- (1) state space equation}$$

$$y_k = H x_k + v_k \quad \text{--- (2) observation equation}$$

x_k - set of data

y_k - set of observed data

Kalman filter works in two steps

1 - Prediction step

2 - correction step

we have considered 1st order AR model

Markov model

$$s(n) = \alpha s(n-1) + w(n) \quad \text{--- state space model}$$

01

February

THURSDAY

WEEK - 5 / DAY (032-333)

DECEMBER							2017	JANUARY						
Wk	M	T	W	T	F	S	S	Wk	M	T	W	T	F	S
49						1	2	01	1	2	3	4	5	6
50	4	5	6	7	8	9	10	02	8	9	10	11	12	13
51	11	12	13	14	15	16	17	03	15	16	17	18	19	20
52	18	19	20	21	22	23	24	04	22	23	24	25	26	27
53	25	26	27	28	29	30	31	05	29	30	31			

$s(0) \ s(1) \ \dots \ s(n-1) \ s(n)$ — states of the system.

$$s(n) = \alpha \ s(n-1) + w(n)$$

$$p(s(n) | s(n-1) \ s(n-2) \ \dots \ s(0)) = p(s(n) | s(n-1))$$

markov process — future behaviour can not be

accurately predicted from its past behaviour except the current behaviour which involves random chance or probability

$$s(n) = \alpha \ s(n-1) + w(n) \quad \text{— state equation}$$

\uparrow Gaussian \uparrow Gaussian \uparrow Gaussian

$$s(n-1) = N(\mu, \sigma^2)$$

$$w(n) = N(0, \sigma_w^2)$$

$$x(n) = h \ s(n) + v(n) \quad \text{— observation equation}$$

estimate $s(n)$ from all observations

$$x(0) \ x(1) \ \dots \ x(N-1)$$

notes

phone

email

website

essential

FEBRUARY 2018							MARCH 2018						
Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su
				1	2	3	01						
04	5	6	7	8	9	10	11	5	6	7	8	9	10
11	12	13	14	15	16	17	18	12	13	14	15	16	17
18	19	20	21	22	23	24	25	19	20	21	22	23	24
25	26	27	28					26	27	28	29	30	31

February 02
FRIDAY

WEEK - 5 / DAY (033-332)

our Goal $\hat{s}(n) = E\{s(n) | x(0) x(1) \dots x(n-1) x(n)\}$

from $\hat{s}(n-1)$ compute $\hat{s}(n)$

$\hat{s}(n)$ depends on $\left\{ \begin{array}{l} \hat{s}(n-1) \\ \text{mean} \end{array} \right., \left\{ \begin{array}{l} p(n-1) \\ \text{covar} \end{array} \right\}$

$$\hat{s}(n-1) = E\{s(n-1) | x(0) x(1) \dots x(n-1)\}$$

$$\hat{s}(n-1|n-1) = E\{s(n-1) | x(n-1)\}$$

$$p(n-1) =$$

$$p(n-1) = p(n-1|n-1) = E\{(s(n-1) - \hat{s}(n-1))^2\}$$

Kalman filter

1- prediction step

2- correction update step

Step-1

1- prediction step - prediction of $s(n)$ based on the previous data

ie. given data $x(0) x(1) \dots x(n-1)$

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03 February

SATURDAY

WEEK - 5 / DAY (034-331)

DECEMBER							2017							JANUARY						
Wk.	M	T	W	T	F	S	S	Wk.	M	T	W	T	F	S	S					
49						1	2	3	01	1	2	3	4	5	6					
50	4	5	6	7	8	9	10		02	8	9	10	11	12	13					
51	11	12	13	14	15	16	17		03	15	16	17	18	19	20					
52	18	19	20	21	22	23	24		04	22	23	24	25	26	27					
53	25	26	27	28	29	30	31		05	29	30	31								

$$\hat{s}(n|n-1) = E\{s(n) | x(0) x(1) \dots x(n-1)\}$$

$$s(n) = \alpha s(n-1) + w(n)$$

$$\hat{s}(n|n-1) = \alpha E\{s(n-1) | x(0) \dots x(n-1)\} + E\{w(n) | x(0) \dots x(n-1)\}$$

$$= \alpha \hat{s}(n-1) + 0$$

$$\hat{s}(n|n-1) = \alpha \hat{s}(n-1)$$

Now co-variance (error co-variance)

$$p(n|n-1) = E\{(\hat{s}(n|n-1) - s(n))^2\}$$

$$= E\{(\hat{s}(n|n-1) - s(n))^2\}$$

$$= E\{(\alpha \hat{s}(n-1) + w(n) - s(n))^2\}$$

04 Sunday

$$p(n|n-1) = \alpha^2 p(n-1) + \sigma_w^2$$

$$s(n) | x(0) x(1) \dots x(n-1) \sim N(\hat{s}(n|n-1), p(n|n-1))$$

Step-II (Correction step) — Now time update step. we estimate $s(n)$ by using $\{x(n) \hat{s}(n-1) \dots x(1)\}$

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			1	2	3	4	08			1	2	3	4
5	6	7	8	9	10	11	10	5	6	7	8	9	10
12	13	14	15	16	17	18	11	12	13	14	15	16	17
19	20	21	22	23	24	25	12	18	19	20	21	22	23
26	27	28					13	26	27	28	29	30	31

February

05

WEEK - 6 / DAY [036-329]

MONDAY

$z(n) = h s(n) + v(n)$. observation equation.
linear eqn

Now estimate $s(n)$ i.e. $\hat{s}(n/n)$ using linear MMSE expression.

$$\hat{s}(n) = R_{sx} R_{xx}^{-1} (x - \mu_x) + \mu_s$$

$$\mu_s = \text{mean of } s(n) = \hat{s}(n/n+1)$$

$$\mu_x = \text{mean of } x(n) = \hat{x}(n/n+1) = h \hat{s}(n/n+1)$$

$$R_{xx} = E\{ (x - \mu_x)^2 \} = h^2 p(n/n+1) + \sigma_v^2$$

$$R_{sx} = E\{ (x - \mu_x) (s - \mu_s) \} = h p(n/n+1)$$

Now

$$\hat{s}(n) = \frac{h p(n/n+1)}{h^2 p(n/n+1) + \sigma_v^2}$$

weighting factor
or
Gain of Kalman

$$z(n) = h \hat{s}(n/n+1) + \hat{s}(n/n+1)$$

error in
prediction

Correction.

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06 February

TUESDAY

WEEK - 6 / DAY (037-328)

DECEMBER							2017	JANUARY						
WL	M	T	W	T	F	S	S	WL	M	T	W	T	F	S
49					1	2	3	01	1	2	3	4	5	6
50	4	5	6	7	8	9	10	02	8	9	10	11	12	13
51	11	12	13	14	15	16	17	03	15	16	17	18	19	20
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53	25	26	27	28	29	30	31	05	29	30	31			

Error covariance (covariance correction update)

$$\begin{aligned}
 E \{ (s(n) - \hat{s}(n))^2 \} &= P_{es} - R_{es} R_{xx}^{-1} R_{es} \\
 &= p(n|n-1) - \frac{h^2 p(n|n-1) \cdot h^2 p(n|n-1)}{h^2 p(n|n-1) + \sigma_v^2} \\
 &= \left[1 - \frac{h^2 p(n|n-1)}{h^2 p(n|n-1) + \sigma_v^2} \right] p(n|n-1) \\
 p(n) &= [1 - h^2 k(n)] p(n|n-1)
 \end{aligned}$$

Dynamic state model in which observation equation depends on parameters that can be tuned to improve the performance

Recently several authors proposed.

for example 1- To track and estimate dynamic wireless channel

2- The parameters to be estimated are the position and velocity of a target

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5	6	7	8	9	10	11	05	5	6	7	8	9	10
12	13	14	15	16	17	18	11	11	12	13	14	15	16
19	20	21	22	23	24	25	17	17	18	19	20	21	22
26	27	28					23	23	24	25	26	27	28
							30	30	31				

February 07

WEEK - 6 / DAY (038-327)

WEDNESDAY

3- Distributed sensor network problem is considered where the observed signal is a linear function of the transmission gain of each sensor.

→ Here we consider the problem of optimizing the parameters (Θ) in order to min the MSE