August 13, 2020

1

¹² µ ³ ³¤½ Σ¬½ ¸¼ ¿¹ £¡ ¥³µ¾ ²» ú£
Ĩ Ŷ ÿ¸ ĵ½´ ¶¼¿ ´ ´ ³£Adelmanµ « µ ¿ ¬ · º
]?] ÷ Ŷ 4¶ »µ ¼ ¨ġ¡£Georgeµ [?]
¹¹½¨ µķ Ŷ ǵ ¬ º ȷ¶¨ ³µ « µ µ¶ ġ£¬²¢µó µ ÿ¸ ´¦ ³µµĿ £ Schuijbroekµ [?]
½«ÿ¸ µ Ĩ¶ ´´ £¬ ó ÿ¸ µ ķ ¡£Kapsiµ [?] ´ ǵ ¬ ¨ µ ¨ õ £
½ ²½Kaspiµ [?]³ µµı º £¬µ« » û§¶
¸ ³µ µ £ µ [? ³µ³¡¾° ¬ ý ¼ £¬ ¥³µµĻ ¹² [

2 ¹ ³¨ġ

¹² ³µµ ġ ġ ¶ ¬µ¥³µµķ¼ ġ£¶ ¼ ¬µ¥³µµ ǻ ® · ġ£Ï ¿ · ½± ±¾¹¤ ² ³µµ

2.1 · ºű

2.1.1 ±

2.1.2 ²

2.2 ġ

µ¥³µ ¿ ´³ óµ · µ³µ

¸ £ÿ¸ Ŷ ¬ ³ Ŷ ½« µ Ĩ

¸ ¸ $M/M/\infty$¶ £ ´ ¥³µµ½´ ĳ¸ ĵ ¶ £ÿ¸ Ĺ ½´ ´ ¶¨² µĲ´ ¼¡£ ĵ¥³µµ½´ ¸ ½ *Pool*£¨¼ ĨBP)¡£µ±» Ļµ³µ $\overline{B}$£¬» û óµ£¬¶ » µ £¬ »µ³µ¾¹ ² Ĩγ ¼ *Repairing Center*£¨¼ Ĩ *Pool*£¨¼ ĨDP)¡£µ±¸ô¦µĺóµ ´ ¶¨ $\overline{D}$£¬» û óµ£¬¶ · ų µ £¬ ³µ³¾¹ ² Ĩδµ ¼ · x · Ų ¾ ¸

3 ġ

¶ ¸ µ l ¼ ¿ t£¬µ± ¼ £¬ ´¦ µı ¸¨¡£¸ · ´ µ ¸ ½³£±¾²¿ · ň¹½¨ µ ½³¬²¢¸ ³

3.1 · ½³¹½¨

¼ SĨ µļ¯º , sĨ¼¯º £¼

$$s^T = (N_1, \ldots, N_A, R_{11}, \ldots, R_{AA}, BP, RC, DP)^T$$

Ĩ

¼ π_sĨ sµļ« ¸ £ Æ I_{N_i}£¬I_{BP}º I_{DP} £º

$$I_{N_i} = \begin{cases} 1, N_i > 0; \\ 0, \quad \cdot \quad . \end{cases}$$

$$I_{BP} = \begin{cases} 1, BP \geq \overline{B} \quad » \; BP + RC + DP = M \wedge BP \neq 0; \\ 0, \qquad\qquad\qquad \cdot \quad . \end{cases}$$

1¹² ³µ Ŷ ģɔ

Table 1 ±

· º	º¬
i, j	¶ Ľű , $i, j = 1, \ldots, A$
t i´¦µĹóµ	¼
R_{ij}	´« i jµijµ
BP	µ±ǰµ ±» ĵĻµ³µ
RC	µ±ǰ ¦µĻµ³µ
DP	µ±ǰµ ±» · ŵĻµ³µ

Table 2² ±

²		Ĭ
A		2
M	µ	6
β		0.3
P_{ij}	´ iµ½jµ	
ρ_{ij}	´ i ½jµ	
γ	»	1.0
$\overline{B}$	»	1
μ	µ¥ ·	1.0
N	·	1
δ	·	1.0
$\overline{D}$	·	2

$$I_{DP} = \begin{cases} 1, DP \geq \overline{D} \quad » \; BP + RC + DP = M \wedge DP \neq 0; \\ 0, \quad\quad\quad\quad \cdot \quad . \end{cases}$$

¿ tµ ¬ µ ³ Ĩ¸ ¿ ½´ µij¤³̲ ³ º£¼´£º

$$Rate-out_s = (\sum_{i\in[1,A]} \lambda_i I_{N_i} + \sum_{i\in[1,A]} \sum_{j\in[1,A]} \rho_{ij} R_{ij} + \gamma I_{BP} + \mu \min\{RC, N\} + \delta I_{DP}) \pi_s$$

.

Æ º ¯ $I_{s'}$ £¬ º ¸ ǿ ģ¬´ Ĩ1£¬²»´ Ĩ0.

$$I_{s'} = \begin{cases} 1, \sum\limits_{i\in[1,A]} (N_i + \sum\limits_{j\in[1,A]} R_{ij}) + BP + RC + DP = M; \\ \quad N_i, R_{ij}, BP, RC, DP \; are \; integers \; in \; [0, M]; \\ 0, \quad\quad\quad\quad \cdot \quad . \end{cases}$$

¿ tµ ¬ µ Ĩ ½´ µ µij¤³̲ ³ º£Ï ȷ¶¨ µ ¶¨» · ¸ ³Ŀ ± ¸ ³

$$B = \begin{cases} BP, BP + RC + DP = M \wedge BP \neq 0; \\ \overline{B}, \quad\quad\quad\quad \cdot \quad . \end{cases}$$

ÿ´ · ŵ ¸ ³

$$D = \begin{cases} DP, BP + RC + DP = M \wedge DP \neq 0; \\ \overline{D}, \quad\quad\quad\quad \cdot \quad . \end{cases}$$

¶ · ǰ¸ Íóµ · Ų ¹ õ½¡£±¾ ¸ ¾ ½´ ´± · IJ £³ Ŀ± ·

¿ ³ £¬¿ ¸ ¾ ¨1£©¹ ºóµ£»£¨2£© ½´ £¨3£© »£¨4£©»µ³µ ģ»£¨5£© .

$$\begin{aligned} &Rate-in_s = \\ &\sum_{i\in[1,A]} \sum_{j\in[1,A]} \lambda_i P_{ij} \pi_{(\ldots,N_i+1,\ldots,R_{ij}-1,\ldots)} I_{(\ldots,N_i+1,\ldots,R_{ij}-1,\ldots)} + \\ &\sum_{i\in[1,A]} \sum_{j\in[1,A]} \rho_{ji} R_{ji} (1-\beta) \pi_{(\ldots,N_i-1,\ldots,R_{ij}+1,\ldots)} I_{(\ldots,N_i-1,\ldots,R_{ij}+1,\ldots)} + \\ &\sum_{i\in[1,A]} \sum_{j\in[1,A]} \rho_{ij} R_{ij} \beta \pi_{(\ldots,R_{ij}+1,\ldots,\ldots,BP-1,\ldots)} I_{(\ldots,R_{ij}+1,\ldots,\ldots,BP-1,\ldots)} + \\ &\gamma \pi_{(\ldots,BP+B,RC-B,\ldots)} I_{(\ldots,BP+B,RC-B,\ldots)} + \\ &\mu \min\{RC, N\} \pi_{(\ldots,RC+1,DP-1)} I_{(\ldots,RC+1,DP-1)} + \\ &\delta \sum_{q\in Q} \pi_q I_q \end{aligned}$$

º

$$\sum_{s\in S} \pi_s = 1$$

¹ jb¡¢ ½³ õ½ ´¦ ÿ¸ µij¤³̲ ¡£¸ ¾ ñ ¿ õ½ µIJ ¡£

3.2 ±

¸ ¾ µij¤³ ¸ ¬ ¼´ ´¦ ÿ¸ µ ± £¬¿ õ½ ǹ ĵ ±

3.2.1 ºóµ¡¢»µ³µ±

óµº µ³µµ ¿ Íóµ

3.2.2 ¹

µ± ij¸ û óµ £¬ µ½´ Ĺ «» µ ¹ û óµµ Ĺ ½´ Ĺ ½´ ¢ õ½ µĹ ± ¡£ ¹ ¶ ¼ ¾ ¼´¿

$$E[^1 \quad] = \frac{1}{M} \sum_{s\in S} \pi_s \sum_{N_i \in s} I(N_i) \lambda_i / \sum_{i\in[1,A]} \lambda_i$$

3.2.3

Ĵ¦¿ · ¡£µ± Ĵ¦´ ĵ¥³µ

3.2.4 » ¢ ¢ · ųµ ±

» ¢ ¢ · ųµ ± ¼´Ĩ» ¢ ¢ · ¸ ³µ ¡£ ǰ óµ± µļ σ£

$$E[\text{BP}\pm\ ] = \frac{1}{M}\sum_{s\in S}\pi_s BP^s$$

$$E[\text{RC}\pm\ ] = \frac{1}{M}\sum_{s\in S}\pi_s RC^s$$

$$E[\text{DP}\pm\ ] = \frac{1}{M}\sum_{s\in S}\pi_s DP^s$$

4

±¾²¿ · ǰ ² ¼ · ¨£¬ õ ġ ¿µ¥³µ ¢ · ¸ ³ĲJ ± £¬¶ ¸ µ ¹ µ

4.1 ²

²¿ · ¬ £³ ¡¢³µ ¨£¬± µĲJ ¡£ ¹ Ļ ¡¢» ¢

Ĩ500´ ¸ ÿ¸ µ ² ¬ º ¬ ¶¨ ² £¬¶¼½« 30´Σ¬ Ĩµ±ǰ² µĽ ¡£

Ĩ ȷ¶¨ ² £¬ ¿ £¬µ¥³µ µĹ ¡£ ?? º¡£ ¸ óµµı ½µ£¬¹ ± » ¦´« ¢ · Ź

4.2

¹ ½ ¿¹² ³µ » · ½ fµ ň µ± f »µĻ · ½ » · ½ ½ ȷ ²

4.2.1 f

¼ · Ź ³ ¤ µ° ġ£ f¡¢³µfµ ³£¿ »¡£ ¹ ¾ġ ¨ ¬¶ ± ¸ ¿ ± ?? º¡

$\overline{B}$º $\overline{D}$¶ µ ġ£µ±$\overline{B}$º $\overline{D}$ £¬ óµµı £¹ ´ ¡£ ¸ £¬ ¾¡¿ ¸

4.2.2 ȷ

±¾²¿ · ĳ · ± ¶ µ ¸ ÿ¸ ¼¿ £¬µ« ¾±¡£± µ · ŵ ¹ ½ ¡£ µ¥¶ » ¢ · » óµ

» ·

5 ½

¹ ½«¹² ³µµķ ³ µ³µ ¹ ³ Ŷ ³¬½«¹² ³µµ ½¨ġ³ Ŷ ¹¹½¨ µ ¿ ţ¡£¹ ¿ ţ´ ĳ¤³ ¨ ± ²½¼ õ½ µ

$$\Delta\beta = \frac{\beta^* - \beta_0}{\beta_0} = \frac{m\rho(\frac{\varphi_1^2}{\sigma_1^2} + \frac{\varphi_2^2}{\sigma_2^2} + \frac{\varphi_3^2}{\sigma_3^2})}{\lambda^2 + m\rho(\sigma^2 - \frac{\varphi_1^2}{\sigma_1^2} - \frac{\varphi_2^2}{\sigma_2^2} - \frac{\varphi_3^2}{\sigma_3^2})}, \tag{1}$$

$$\Delta e = \frac{e^* - e_0}{e_0} = \frac{m\rho(\frac{\varphi_1^2}{\sigma_1^2} + \frac{\varphi_2^2}{\sigma_2^2} + \frac{\varphi_3^2}{\sigma_3^2})}{\lambda^2 + m\rho(\sigma^2 - \frac{\varphi_1^2}{\sigma_1^2} - \frac{\varphi_2^2}{\sigma_2^2} - \frac{\varphi_3^2}{\sigma_3^2})}, \tag{2}$$

$$\Delta E(v) = \frac{E(v)^* - E_0(v)}{E_0(v)} = \frac{\lambda^4 m\rho(\frac{\varphi_1^2}{\sigma_1^2} + \frac{\varphi_2^2}{\sigma_2^2} + \frac{\varphi_3^2}{\sigma_3^2})}{(\lambda^2 + m\rho(\sigma^2 - \frac{\varphi_1^2}{\sigma_1^2} - \frac{\varphi_2^2}{\sigma_2^2} - \frac{\varphi_3^2}{\sigma_3^2}))(\lambda^4 - 2\overline{\mu}m(\lambda^2 + m\rho\sigma^2))}, \tag{3}$$

$$\Delta AC = \frac{AC_0 - AC}{AC_0} = \frac{\lambda^2(\frac{\varphi_1^2}{\sigma_1^2} + \frac{\varphi_2^2}{\sigma_2^2} + \frac{\varphi_3^2}{\sigma_3^2})}{\sigma^2(\lambda^2 + m\rho(\sigma^2 - \frac{\varphi_1^2}{\sigma_1^2} - \frac{\varphi_2^2}{\sigma_2^2} - \frac{\varphi_3^2}{\sigma_3^2}))}. \quad (4)$$

±¾ ¸µ , ¼¸¸ :

± : ° ° º¬ ¼¶± , ¶ ¼¶± ¼¶± , : 2; 2.1; 2.1.1µ .

² ¼ : µĲ ¼ «¿ª · ¢± ģ¬ Ĩ ¡£ ¼´£º Ĳ ¼ ¸ð´´ µ½´ , : ¿ ½ · ¨ [?,?], µ ³º ¶ ¿ ķ¢ [?,?,?,?], ´ , , · ¼² µ [?,?,?]. ¿ ½ · ¨ ¸ · ¼ ¾ [?].

² ¼ ¼¸ :

µ ģº ¸¯ (ĵ º). L[J]. , ¯ , ¾ ( )£º ¾ ² ¼ [?,?,?,?,?,?,?,?].

, ļ¯, , ±¨¸ (ĵ º). [M¡¢C¡¢D¡¢R]. ° . º³ ³ ³ : . ² ¼ [?,?,?,?,?,?,?,?].

ļ¯ £º (ĵ º). [M¡¢C]// ( ). . : ³¬ º³ ³ .

µ . µ . ² ¼ [?,?,?].

· ² · ǹ«¿ª³ Ļ ¼ 8, , , ²¢ µ , µ« ¶ ¦¿ .

· º: · º, x, y, zµ . µ ¿ · ¾ Ĺ« µ .

² : ü » (EPS), ² µĺ«¶ ¸ ° Ļ ±¾ , · ´600 / ´ . ; Ķ · ºš¢µ¥ µ ± ; 6º ; ±

, ± µ · ½, µ 4½ .

± : ± , :´¼ ± û , (Ï), ô , ; ; ¶ ¾ ± ¾ , ¾«ĵ¶ . ¹ ½. µ 5½ .

1 . , ¹ º .º ²¢

6 û · ¾³

Æ¸¸ , . ¨ û · ¾³

¶¨ 1 $(e_k^{(1)}(t), e_k^{(2)}(t)) \in S$, ¹ ³ b

$$e_{k+1}^{(1)}(t) = G_i e_k^{(1)}(t) + F_i(x_{k+1}^{(1)}(t) - x_k^{(1)}(t)), \quad (5)$$

$$\begin{aligned} G_1 &= I - (I - C_{12}\hat{C}_2^{-1}C_1)DL_1, \\ G_2 &= I - (I + C_{12}C_{22}^{-1}C_2^{-1}C_1)^{-1}DL_1, \\ F_1 &= -C_{11} + C_{12}\hat{C}_2^{-1}\hat{C}_1, \\ F_2 &= (I + C_{12}C_{22}^{-1}C_2^{-1}C_1)^{-1}(-C_{11}C_{22}^{-1}C_{21}), \end{aligned}$$

Ĩ ĵ ´ ¿ Ĩ

$$u_{k+1} = u_k + Le_k, \ k = 1, 2, \cdots, \quad (6)$$

$e_k = y_d - y_k, y_d$, y_k k´ u_kµ ¼ . LĨ ¾ , °

$$\|I - DL\| < 1, \ » \ \rho(I - DL) < 1. \quad (7)$$

± .

1 $i = 1, 2$µ , $\|x_{k+1}^{(1)}(t) - x_k^{(1)}(t)\|$ ¹<

$$\|x_{k+1}^{(1)} - x_k^{(1)}\|_\lambda \leqslant \frac{1}{1-h_1(i)}\|x_{k+1}^{(1)}(0) - x_k^{(1)}(0)\| + \frac{h_2(i)}{1-h_1(i)}\|e_k^{(1)}\|_\lambda + \rho(Q), \tag{8}$$

$\rho(Q)$Ï¾ Qµ . ´ (1)¿ , ¾ L µþ DLû . , λ Ó $I - DL$µ , $\|I - DL\| < 1$, $|\lambda| < 1$.

1 (2), C_1, C_2, L_1 µ $\|G_i\| + h < 1$(» $\rho(G_i) + h < 1$), $i = 1, 2$; $(e_k^{(1)}(t), e_k^{(2)}(t)) \in S$,

$$\lim_{k\to\infty} e_k^{(1)}(t) = \lim_{k\to\infty} e_k^{(2)}(t) = 0, t \in [0, T],$$

¼´ S (2)µ ¨ . h (3) ¶¨µ .

¶¨ 1 ¶¨ ³

$$y_1 = C_{11}x_1 + C_{12}x_2 + D_{11}u_1. \tag{9}$$

7 ¹« µ

.¼ ± £ õĹ« µ Ï² ³ ɔ.

7.1 1

³ 4¸ µķ½³

$$\begin{cases} \dot{x}(t) = A^c x(t) + B^c u(t) + E^c d(t) \\ z(t) = C^c x(t), \\ t \in \mathbb{R}^+. \end{cases} \tag{10}$$

7.2 2

³ »µ .

(1 ¿ ·

$$\begin{pmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{pmatrix}. \tag{11}$$

2) ¾ µ

$$A_1 = \begin{bmatrix} 1 & -2 \\ -2 & 4 \end{bmatrix}, \tag{12}$$

$$A_2 = \begin{bmatrix} 1.1 & -2.7 \\ -2.3 & 4.6 \end{bmatrix}. \tag{13}$$

3) µ ¹« µ .

\displaystyle ¿ µĹ« . $f(z) \approx \dfrac{1 + \frac{1}{2}z + z^2 + \frac{1}{2}z^3}{1 - \frac{1}{2}z + z^2}$. ǰ µ .

\textstyle ¿ ¹« ´ .

$$\boldsymbol{z}^{\mathrm{T}}(t)\{A_q^{\mathrm{T}}[P(t) + I]A_q - [P(t) + I]\}\boldsymbol{z}(t) + \sum_{i=1}^{m}\int_{t-\tau_i}^{t} \boldsymbol{z}^{\mathrm{T}}(s)\{A_q^{\mathrm{T}}A_q - I\}\boldsymbol{z}(s)\mathrm{d}s \leqslant 0. \tag{14}$$

4) ¹« µı .

õĹ« ± . ¶ « µı ſ ¹ \begin{$equation$} ...\end{$equation$} » \begin{$eqnarray$} ... \end{$eqnarray$}

4 , ¾ « µ : (??), (??),..., (??). ¶ ²» ± ŵĵ¥ « , ¿ ¹ \begin{*eqnarray*∗} ... \end{*eqnarray*∗}4 ; ¿ ¹ $ 4 , .

8 ² (Figures)

.¼ ± £ õĹ« µ Ĩ² ³ Latex¶ : ü » (EPS), Ļ · ¾³² . °trim=0 0 0 0¡±4¿ , ¿ ¹ 4¸ 4 ¯ . °trim=0 0 0 0¡±4¿ , ¿ ¹ 4¸ 4 ¯ . ¸³ 4¸ ͻ´ ¡¢± ¡¢ ¡¢ ±»¹ ± ͻ´ ½ µĴ , ¶ ¸º ± ͻ´ ¼ Ĵ .

1

Fig. 1 Title of figure

9 ± (Tables)

¸ .

± 1 ģº ¿

Table 1 Fuzzy control rules

e	Δe						
	NB	NM	NS	ZO	PS	PM	PB
NM	NB	NM	NS	ZO	PS	PM	PB
NS	NB	NM	NS	ZO	PS	PM	PB
NO	NB	NM	NS	ZO	PS	PM	PB
NM	NB	NM	NS	ZO	PS	PM	PB
NM	NB	NM	NS	ZO	PS	PM	PB

± 2 º Ĳ [?]

Table 2 The parameters used in Monkey Algorithm

²	
º ¹ ģ	$M = 5$
2½³¤	$a = 0.001$
4	$N_c = 50$
³¤¶	$b = 0.3$
¼	$[c, d]$ = [-1,1]
» · ´	$N = 60$

² ¼ :

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¸½¼ ¸½¼±

$$\frac{\partial \Delta E(v)}{\partial \lambda} = -\frac{\lambda^3 m\rho(\frac{\varphi_1^2}{\sigma_1^2} + \frac{\varphi_2^2}{\sigma_2^2} + \frac{\varphi_3^2}{\sigma_3^2})}{(\lambda^4 - 2\overline{\mu}m(\lambda^2 + m\rho\sigma^2))^2}.$$

2500´ » · ¾³½

3 ² ± ¹