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Nash

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Nash (1953)

Nash

“Shared Vision Model”

Palmer et al. (1999)

Kum

STELLA®

Nandalal and Bogardi (1995, 1996)

DYRESM

SDP

¹ Bargaining theory
² Nash product



Nash

$$\bar{d} = (d_1, \dots, d_n) \quad (f_i)$$

$$:(\quad)$$

$$\text{Maximize } Z = (f_1 - d_1)^{w_1} (f_2 - d_2)^{w_2} \dots (f_n - d_n)^{w_n} \quad ()$$

$$\text{Subject to: } f_i \geq d_i \quad i = 1, 2, \dots, n \quad ()$$

$$w_i \quad n$$

i

¹ Stakeholders



Nash

$$\text{Maximize: } Z = \left\{ \prod_{m=1}^{12} E \left[(f_{r,m}(R_{m,i,j}) - d_{r,m})^{w_r} (f_{s,m}(\hat{S}_{m+1,i,j}) - d_{s,m})^{w_s} \right] \right\}^{w_s} \times$$

$$\left\{ \prod_{m=1}^{12} \prod_{h=1}^H (f_{c,m}(\bar{C}_{m,h}) - d_{c,m}) \right\}^{w_c/H} \times \left\{ \prod_{m=1}^{12} \prod_{h=1}^G ((f_{e,m}(\bar{e}_{m,g}) - d_{e,m})) \right\}^{w_g/G} \quad \forall i, j ()$$

Subject to:

$$\hat{S}_{m+1,i,j} = P'_m(\hat{S}_i, \hat{I}_j, m) \quad m = 1, \dots, 12, i = 1, \dots, n_i, j = 1, \dots, n_j \quad ()$$

$$E \left[(f_{r,m}(R_{m,i,j}) - d_{r,m})^{w_r} (f_{s,m}(\hat{S}_{m+1,i,j}) - d_{s,m})^{w_s} \right] = \sum_{n=1}^N \sum_{m=1}^{12} \sum_{i=1}^{n_i} \sum_{j=1}^{n_j} (F_{n,m,i,j}) - \sum_{n=1}^{N-1} \sum_{m=1}^{12} \sum_{i=1}^{n_i} \sum_{j=1}^{n_j} (F_{n,m,i,j}) \quad ()$$

$$F_{n,m,i,j} = (B_{m,i,j} + \sum_{l=1}^{n_j} F_{n,m-1,i,l} \times P_{j,l}) \quad ()$$

$$B_{m,i,j} = (f_{r,m}(R_{m,i,j}) - d_{r,m})^{w_r} (f_{s,m}(\hat{S}_{m+1,i,j}) - d_{s,m})^{w_s} \quad ()$$

$$R_{m,i,j} = \hat{S}_i - \hat{S}_{m+1,i,j} + \hat{I}_j - L_{m,i,j} \quad m = 1, \dots, 12, i = 1, \dots, n_i, j = 1, \dots, n_j \quad ()$$

¹ Expected value



$$R_{m,i,j} = r_{m,i,j}^1 + r_{m,i,j}^2 + \dots + r_{m,i,j}^P \quad m = 1, \dots, 12, i = 1, \dots, n_i, j = 1, \dots, n_j \quad ()$$

$$r_{m,i,j}^k = \alpha_{m,i,j}^k \cdot R_{m,i,j} \quad k = 1, \dots, P \quad m = 1, \dots, 12, i = 1, \dots, n_i, j = 1, \dots, n_j \quad ()$$

$$\sum_{k=1}^P \alpha_{m,i,j}^k = 100 \quad \forall m, i, j \quad ()$$

$$R_{m,y} = S_{m,y} - S_{m+1,y} + I_{m,y} - L_{m,y} \quad 1 \leq m \leq 11, 1 \leq y \leq Y \quad ()$$

$$R_{m,y} = S_{m,y} - S_{m+1,y} + I_{m,y} - L_{m,y} \quad m = 12, 1 \leq y \leq Y \quad ()$$

$$r_{k,m,y} = \alpha_{m,i,j}^k \cdot R_{m,y} \quad ()$$

$$S_{min} \leq S_{m,y} \leq S_{max} \quad ()$$

$$0 \leq r_{k,m,y} \leq r_{k,max} \quad \forall k, m, y \quad ()$$

$$0 \leq r_{m,i,j}^k \leq r_{k,max} \quad \forall k, m, y \quad ()$$

$$C_{k,m,y} = g(\tilde{T}, \tilde{w}, \tilde{C}_{in}, \tilde{T}_{in}, \tilde{I}, \tilde{r}_k) \quad \forall m, y, k \quad ()$$

$$0 < e_{m,g} < e_{m,g,max} \quad ()$$

$$\bar{C}_{m,y} = \sum_k^P r_{k,m,y} \times C_{k,m,y} / r_{m,y} \quad ()$$

$$c_{m,y,h} = g'(\tilde{T}, \tilde{w}, C'_{m,y}, \tilde{C}_{pl}, \tilde{Q}_{pl}, \tilde{E}_s, \tilde{P}_h, \tilde{W}, \tilde{e}) \quad ()$$

$$q_{m,y,h} = g''(R_{m,y}, \bar{Q}_{pl}, \bar{P}_h, \bar{W}) \quad ()$$

$$\bar{c}_{m,h} = \sum_{y=1}^Y (q_{m,y,h} \times C_{m,y,h}) / (\sum_{y=1}^Y q_{m,y}) \quad ()$$

$$0 \leq e_{m,g} \leq e_{m,g,max} \quad ()$$

$$: \alpha_{m,i,j}^k$$

$$: B_{m,i,j}$$

m



$C_{k,m,y}$
 $\bar{C}_{m,y}$
 $c_{m,y,h}$
 $\bar{c}_{m,h}$
 \tilde{C}_{pl}
 \tilde{C}_{in}
 $d_{r,m}$
 $d_{s,m}$
 $d_{c,m}$
 $d_{e,m}$
 $E()$
 \bar{E}_s
 $\bar{e}_{m,g}$
 \tilde{e}
 $e_{m,g,max}$
 $f_{r,m}()$



) m : $f_{s,m}()$

.(

: $f_{c,m}()$

) m

.(

: $f_{e,m}()$

) m

.(

: G

: $g()$

: $g'()$

)

: $g''()$

(



H
 i
 \hat{I}_j
 $I_{m,y}$
 \tilde{I}
 j
 $L_{m,y}$
 $L_{m,i,j}$
 l
 n_i
 n_j
 N
 n
 P
 $P'_m(\hat{S}_i, \hat{I}_j, m)$
 $P_{j,l}$
 \tilde{P}_h
 \tilde{Q}_{pl}
 $q_{m,y,h}$



i m j $: R_{m,i,j}$
 $)$ y m j $: R_{m,y}$
 $($ $: \tilde{R}$
 i m k $: r_{m,i,j}^k$
 y m k $: r_{k,m,y}$
 $($ $)$ k $: r_{k,max}$
 i m j $: \hat{S}_{m+1,i,j}$
 $($ $)$ j $: S_{min}$
 $($ $)$ $: S_{max}$
 $($ $)$ t $: S_{m,y}$
 $($ $)$ i $: \hat{S}_i$
 $($ $)$ $: \tilde{T}$
 $($ $)$ $: \tilde{T}_{in}$
 $: \tilde{W}$
 $: w_r / w_s / w_c / w_g$
 (w_s) (w_r)
 (w_g) (w_c)



$:w_{rs}$

()

$:\tilde{w}$

$:Y$

$:y$

Nash

Kerachian and Karamouz (2004)

(SGA)

¹ Sequential Genetic Algorithms



HEC5-Q

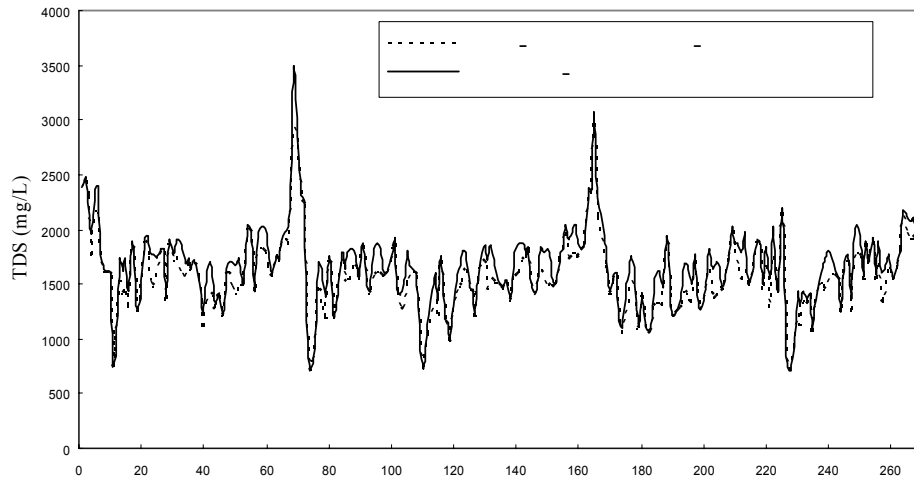
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$$\begin{aligned}
 & : \\
 f_{r,m}(R_m) &= \begin{cases} R_m / d_m & \text{if } R_m \leq d_m \\ 1 & \text{otherwise} \end{cases} \quad () \\
 f_{s,m}(S_{m+1}) &= \begin{cases} (S_{m+1} - 35) / (95) & \text{if } 35 \leq S_{m+1} \leq 130 \\ 1 & \text{otherwise} \end{cases} \quad () \\
 f_{c,m}(C_m) &= \begin{cases} 0 & \text{if } \bar{C}_m > 3000 \\ 1 - \frac{\bar{C}_m - 1200}{3000 - 1200} & \text{if } 1200 \leq \bar{C}_m \leq 3000 \\ 1 & \text{if } 1100 \leq \bar{C}_m < 1200 \\ 0.9 + \left(\frac{0.1 \times \bar{C}_m}{1100} \right) & \text{if } \bar{C}_m < 1100 \end{cases} \quad \text{for } m = 1, \dots, 8, 12 \quad () \\
 f_{c,m}(C_m) &= \begin{cases} \bar{C}_m / 1900 & \text{if } \bar{C}_m < 1900 \\ 1 & \text{if } \bar{C}_m \geq 1900 \end{cases} \quad \text{for } m = 9, 10, 11 \quad () \\
 f_{e,m}(\bar{e}_m) &= \begin{cases} \frac{-1 \times (\bar{e}_m - 10)}{(100 - 10)} + 1 & \text{if } \bar{e}_m > 10 \\ 1 & \text{if } \bar{e}_m \leq 10 \end{cases} \quad ()
 \end{aligned}$$



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$$\begin{aligned} & l \quad (w_{rs}) \\ & (w_c = 0.56) \quad l \quad l \\ & l \quad (w_r) \end{aligned}$$

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