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BUL ALGEBRASI FUNKSIYALARI SISTEMASINI POST TEOREMASI ASOSIDA TO‘LIQLIKKA TEKSHIRISH

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Annotatsiya: Maqolada to`liq funksiyalar sistemasiga ta’rif va Post teoremasi yordamida funksiyalar sistemasini to`liqlikka tekshirishning chinlik jadvali asosida yaratilgan yangi algoritmlari qo`llanilgan. Murakkablik darajasi o`rtacha bo`lgan misol shu algoritmlar asosida yechilgan va natijalari olingan.

Kalit so‘zlar: Funksiyalar sistemasining to`liqligi, yopiq sinflar, Post teoremasi, Post jadvali, P_0 - nol saqlovchi funksiyalar sinfi, P_1- bir saqlovchi funksiyalar sinfi, M - monoton funksiyalar sinfi, S - o’z-oziga ikki taraflama-dual funksiya sinfi, L - chiziqli funksiyalar sinfi.

Kirish

Mantiq algebrasining $F=(f_1,f_2,...f_n)$ funksiyalar sistemasi berilgan bo‘lsin.

Agar mantiq algebrasining istalgan funksiyasini $F=(f_1,f_2,...f_n)$ sistemadagi funksiyalar superpozitsiyasi orqali ifodalash mumkin bo‘lsa, u holda F sistema to‘liq funksiyalar sistemasi deb ataladi.

Mantiq algebrasida hammasi bo‘lib beshta maksimal funksional yopiq sinf mavjud. Bular quyidagilardir: P_0-nol saqlovchi, P_1-bir saqlovchi, M-monoton, S-o`z-o`ziga ikki taraflama, L-chiziqli.

Post teoremasi yordamida funksiyalar sistemasi to`liqlikka tekshiriladi.

Asosiy qism

Amerikalik olim E.Post tomonidan funksiyalar sistemasi to‘liqligining yetarli va zarur shartlari topilgan.

Post teoremasi. $F = \{f_1, f_2, f_3,.....,f_n\}$ funksiyalar sistemasi to‘liq bo‘lishi uchun bu sistemada P_0, P_1, M, S, L maksimal funksional yopiq sinflarning har biriga kirmaydigan kamida bitta funksiya mavjud bo‘lishi yetarli va zarur (ya’ni $F = \{f_1, f_2, f_3,.....,f_n\}$ funksiyalar sistemasi faqat P_0, P_1, M, S, L maksimal funksional yopiq sinflardan birortasining ham qism to‘plami bo‘lmaganda va faqat shundagina to‘liq sistema bo‘ladi.

Post jadvali

F	P_0	P_1	M	L	S
f_1					
...	...	...	...	...	...
f_n					

Post jadvali asosida quyidagi misolnito`liqlikka tekshiramiz.

Misol: $F = \{(x \to \bar{y}) \cdot z;\ \bar{x} \vee \overline{y \downarrow z}; (x \to \bar{y}) \oplus z;\ \bar{x} \oplus yz\}$

$$\begin{cases} f_1 = (x \to \bar{y}) \cdot z \\ f_2 = \bar{x} \vee \overline{y \downarrow z} \\ f_3 = (x \to \bar{y}) \oplus z \\ f_4 = \bar{x} \oplus yz \end{cases}$$

Ushbu funksiyalarning chinlik jadvalini tuzamiz.

x	y	z	f_1	f_2	f_3	f_4
0	0	0	0	1	1	1
0	0	1	1	1	0	1
0	1	0	0	1	1	1
0	1	1	1	1	0	0
1	0	0	0	0	1	0
1	0	1	1	1	0	0
1	1	0	0	1	0	0
1	1	1	0	1	1	1

P_0 - Nol saqlovchilikka tekshirish: Nol saqlovchilikga tekshirish uchun chinlik jadvali qiymatlar satrining 1-chi satrdagi (x,y,z – o`zgaruvchilarning qiymatlari yolg`on bo`lgan) qiymatda $f$ funksiya 0 bo'lsa bu funksiya nol saqlovchi funksiya bo`ladi.

Yoki, analitik usulda ham aniqlaymiz:

- $f_1(0,0,0) = (0 \to \bar{0}) \cdot 0 = 0$ - nol saqlovchi.
- $f_2(0,0,0) = \bar{0} \vee \overline{0 \downarrow 0} = 1$ - nol saqlovchi emas
- $f_3(0,0,0) = (0 \to \bar{0}) \oplus 0 = 1$ - nol saqlovchi emas
- $f_4(0,0,0) = \bar{0} \oplus 0 \cdot 0 = 1$ - nol saqlovchu emas

P_1 - Bir saqlovchilikka tekshirish: Berilgan chinlik jadvali qiymatlar satrining so`nggi ustunidagi qiymatlarida (ya'ni o`zgaruvchilarning barchasi rost qiymat qabul qilsa) f funksiyaning qiymati 1 bo'lsa, bu funksiya bir saqlovchi funksiya bo`ladi.

Analitik usulda:

- $f_1(1,1,1) = (1 \to \bar{1}) \cdot 1 = 0$ - Bir saqlovchi emas;
- $f_2(0,0,0) = \bar{1} \vee \overline{1 \downarrow 1} = 1$ - Bir saqlovchi;
- $f_3(0,0,0) = (1 \to \bar{1}) \oplus 1 = 1$ - Bir saqlovchi;
- $f_4(0,0,0) = \bar{1} \oplus 1 \cdot 1 = 1$ - Bir saqlovchi.

M – Monotonlikga tekshirish: chinlik jadvalidan ko'rinib turibdiki biz ishloyatgan funksiyalar chinlik jadvalidagi qiymatlar satri yuqoridan pastga qarab o'suvchi yoki o`zgarmas emas. Shu uchun funksiyalar monoton emas.

S – O`z-o`ziga ikki taraflamalikka tekshirish: Funksiyalarni dualikka tekshirishni chinlik jadval asosida qiymatlar satri n ta bo'lgan funksiya berilgan bo'lsin. Bu satrlarda quyidagi $x_1 = \overline{x_n}, x_2 = \overline{x_{n-1}}, \ \dots \ , x_{\frac{n}{2}} = \overline{x_{\frac{n}{2}+1}}$

shartlar bajarilsa dual bo'ladi.

f_1 – Monoton emas, dual emas	f_3 – Monoton emas,dual emas
f_2 – Monoton emas, dual emas	f_4 – Monoton emas ,dual emas

Chiziqlilikga tekshirish: chiziqlilikga tekshirish uchun bul funksiyasini jegalkin ko'phadiga yoyamiz. Jegalkin ko'phadida ko'paytma amali qatnashmasa bu funksiya chiziqli bo'ladi.

$f_1 = (x \to \bar{y})z = (x \to \bar{y})z = \left(\overline{\overline{x \to \bar{y}}}\right)z = \overline{xy}z = (xy+1)z = xyz + z$ chiziqli emas

$f_2 = \bar{x} \vee \overline{y \downarrow z} = \overline{\overline{x \vee y \vee z}} = x\bar{y}\bar{z} \oplus 1 = x(y \oplus 1)(z \oplus 1) \oplus 1 = xyz \oplus xy \oplus xz \oplus x \oplus 1$ chiziqli emas

$f_3 = (x \to \bar{y}) \oplus z = \overline{(\bar{x} \vee \bar{y})} \oplus z = \overline{xy} \oplus z = xy \oplus z \oplus 1$ chiziqli emas

$f_4 = \bar{x} \oplus yz = x \oplus yz \oplus 1$ chiziqli emas

F	P_0	P_1	M	L	S
f_1	+	-	-	-	-
f_2	-	+	-	-	-
f_3	-	+	-	-	-
f_4	-	+	-	-	-

Post jadvalidan ko'rinib turibdiki, yuqorida keltirilgan funksiyalar sistemasi to'liq, chunki har bir sistema uchun jadvalda bitta ustunda kamida bitta "-" ishtirok etgan. Shuni ham ta'kidlash kerakki, har bir sistema uchun bu ustunlar har xil.

Post teoremasi orqali Bul funksiyalari sistemasini to`liqlikka tekshirishda yangi usuldagi algoritmlarlardan, jumladan funksiyani L-chiziqlilikka tekshirish uchun bir necha xil usullar mavjud biz yuqorida qo`llagan usul algoritm tuzish uchun va keyinchalik dasturiy vositalar yordamida funksiyalar sistemasini to`liqlikka tekshirish uchun minimal talab va maksimal natijadir.

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THE ROLE OF ARTIFICIAL INTELLIGENCE IN ENHANCING THE PERFORMANCE OF SHELL AND TUBE HEAT EXCHANGERS IN THE CHEMICAL INDUSTRY

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Annotation: Shell and tube heat exchangers are fundamental components in the chemical industry, responsible for efficient heat transfer processes critical for various manufacturing operations. As the chemical industry continues to evolve and strive for increased efficiency and sustainability, the integration of artificial intelligence (AI) technologies has emerged as a promising avenue to optimize the operation and performance of these heat exchangers. This paper explores the current state of shell and tube heat exchangers in the chemical industry and investigates the pivotal role that AI plays in improving their efficiency, reliability, and overall effectiveness. We delve into the applications of AI in the design, monitoring, and control of heat exchangers, highlighting key benefits and challenges associated with its implementation.

Keywords: Artificial Intelligence (AI), Shell and Tube Heat Exchangers, Chemical Industry, Heat Exchanger Design, Heat Exchanger Optimization, Machine Learning, Energy Efficiency, Monitoring and Control, Process Optimization, Data Analytics, Predictive Maintenance, Computational Fluid Dynamics (CFD), Heat Transfer Efficiency, Sustainability, Industrial Automation, Fault Detection and Diagnosis, Thermal Performance, Materials Selection, Energy Savings, Operational Efficiency

Introduction. The chemical industry is characterized by its energy-intensive processes, where heat exchangers play a vital role in heat recovery and temperature control. Shell and tube heat exchangers are widely used due to their versatility, high heat transfer efficiency, and robust design. However, traditional approaches to the design and operation of these heat exchangers often rely on simplified models and manual adjustments, leaving room for improvement in terms of energy efficiency, sustainability, and cost-effectiveness.

Artificial intelligence, particularly machine learning and data analytics, has gained significant attention in recent years for its potential to optimize various industrial processes, including those involving heat exchangers. This paper explores the applications of AI in enhancing the performance of shell and tube heat exchangers in the chemical industry, addressing both theoretical and practical aspects.