文章编号:1671-9352(2007)07-0054-04

$(F,\bar{F})$-规律推理与规律挖掘

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摘要:给出了$(F,\bar{F})$-规律推理以及$(F,\bar{F})$-规律推理的规律挖掘概念,提出了$(F,\bar{F})$-规律推理的规律挖掘定理与$(F,\bar{F})$-规律推理的规律挖掘原理.

关键词:函数单向 S-粗集;函数单向 S-粗集对偶;$(F,\bar{F})$-规律推理,规律挖掘;$(F,\bar{F})$-规律推理挖掘原理
中图分类号:O195; TP181　　**文献标识码**:A

$(F,\bar{F})$-law inference and law mining

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Abstract: Given the conceptions of $(F,\bar{F})$-law inference and law mining of $(F,\bar{F})$-law inference, a law mining theorem and law mining principle of $(F,\bar{F})$-law inference is put forward. The law mining of $(F,\bar{F})$-law inference is a new direction for seeking an unknown law in a system.

Key words: function one direction singular rough sets; dual function one direction singular rough sets; $(F,\bar{F})$-law inference, law mining; the principal of law mining of $(F,\bar{F})$-law inference

0　引言

一个常见的事实:一个系统在未受到外部因素(或内部因素)干扰时,系统具有的规律(系统规律)保持稳定.如果系统受到外部因素(或内部因素)干扰时,系统具有的规律将发生紊乱.能否利用推理的方式知道:若系统受到外部因素干扰,又受到内部因素干扰时,系统规律如何变化[1~4]? 对于认识动荡的投资规律,无疑是非常重要的.换一个说法,潜藏在系统中,还未被人们认识到的系统规律,能否利用推理的方式,把它从系统中挖掘出来? 如果这个设想能够实现,我们就能够事先知道:当系统既受到外部因素干扰,又受到内部因素干扰时,系统规律的变化与系统规律的结构.本文给出$(F,\bar{F})$-规律推理的概念,给出$(F,\bar{F})$-规律推理的规律挖掘.

函数 S-粗集[5,6]是用 R-函数等价类$[u]$定义的,函数 S-粗集具有规律特征.函数单向 S-粗集[5,6],函数单向 S-粗集对偶[5,6]是函数 S-粗集的两类基本形式.函数单向 S-粗集,函数单向 S-粗集对偶为本文的讨论给

收稿日期:2006-04-18
基金项目:国家自然科学基金资助项目(60364001,70461001);福建省自然科学基金项目(Z0511049);山东省自然科学基金项目(Y2004A04)
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出了理论支持.本文的结果是利用函数单向 S-粗集与函数单向 S-粗集对偶得到的,它们的结构、特征见[5, 6].

约定 在 1,2 的讨论中,R-函数等价类$[u]$称作规律$[u]$;函数等价类$[u]$,规律$[u]$,不加区别,直接使用.$\alpha\cup\{f(\beta_i)\}$表示对 α 属性补充,记作$(\alpha\leftarrow f)$;$\alpha\setminus\{f(\alpha_i)\}$表示对 α 属性删除,记作$(\alpha\rightarrow\bar{f})$;$\alpha\setminus\{f(\alpha_i)\}\cup\{f(\beta_i)\}$表示既对 α 属性删除,又对 α 属性补充,记作$((\alpha\rightarrow\bar{f})\leftarrow f)$.

在 1 的讨论中,给定规律$[\mathscr{U}]$;$[u]_i$,$[u]_j$ 是$[\mathscr{U}]$的子规律;$((\alpha\rightarrow\bar{f})\leftarrow f)_i$ 是$[u]_i$ 的属性集,$((\alpha\rightarrow\bar{f})\leftarrow f)_j$ 是$[u]_j$ 的属性集;α 是$[\mathscr{U}]$的属性集;“$\Rightarrow$”是“单蕴含”,“$\Leftrightarrow$”是“双蕴含”.

1 $(F,\bar{F})$-规律推理与规律挖掘特征

定义 1.1 给定规律$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$,$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}\in[\mathscr{U}]$;$((\alpha\rightarrow\bar{f})\leftarrow f)_i$,$((\alpha\rightarrow\bar{f})\leftarrow f)_j$ 是$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$,$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}$ 的属性集,$((\alpha\rightarrow\bar{f})\leftarrow f)_j\subseteq((\alpha\rightarrow\bar{f})\leftarrow f)_i$,称 $\mathrm{MID}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i})$ 是$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$ 关于$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}$的规律挖掘度(mining degree),简称$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$的挖掘度,如果

$$\begin{aligned}\mathrm{MID}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}) = \mathrm{SUR}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i})/\mathrm{card}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}) =\\ 1-\mathrm{CHV}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}).\end{aligned}\tag{1.1}$$

称 $\mathrm{SUR}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i})$是$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$关于$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}$的挖掘剩余(surplus),简称$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$的挖掘剩余,如果

$$\mathrm{SUR}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}) = \mathrm{card}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}) - \mathrm{card}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}).\tag{1.2}$$

定义 1.2 称 $\mathrm{CHV}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i})$是$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$关于$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}$的挖掘$(F,\bar{F})$-特征值(characteristic value),简称$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$的挖掘$(F,\bar{F})$-特征值,如果

$$\mathrm{CHV}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}) = \mathrm{GRD}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i})/\mathrm{GRD}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}).\tag{1.3}$$

这里:$\mathrm{GRD}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i})$是$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$的粒度[2].

在下面的讨论中,设$[\mathscr{U}]$是 $\mathscr{D}$ 上的规律,$[u]_i\subset[\mathscr{U}]$是$[\mathscr{U}]$的子规律,$[u]_i=\{u_1,u_2,\cdots u_n\}$,$i=1,2,\cdots m$;利用定义 1.1~1.2,容易证明:

定理 1.1(规律单蕴含-双蕴含规律挖掘定理) 设$((\alpha\rightarrow\bar{f})\leftarrow f)_i$,$((\alpha\rightarrow\bar{f})\leftarrow f)_j$ 分别是$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$,$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}$的属性集

1° 若$((\alpha\rightarrow\bar{f})\leftarrow f)_i\Rightarrow((\alpha\rightarrow\bar{f})\leftarrow f)_j$,则$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$,$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}\in[\mathscr{U}]$的挖掘度满足

$$\mathrm{MID}(\mathrm{IND}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}))\leq\mathrm{MID}(\mathrm{IND}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j})).\tag{1.4}$$

2° 若$((\alpha\rightarrow\bar{f})\leftarrow f)_i\Leftrightarrow((\alpha\rightarrow\bar{f})\leftarrow f)_j$,则$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$,$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}\in[\mathscr{U}]$的挖掘度满足

$$\underset{((\alpha\rightarrow\bar{f})\leftarrow f)}{\mathrm{IND}}(\mathrm{MID}(\mathrm{IND}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i})),\mathrm{MID}(\mathrm{IND}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}))).\tag{1.5}$$

证明 1° 事实上,因为$((\alpha\rightarrow\bar{f})\leftarrow f)_i\Rightarrow((\alpha\rightarrow\bar{f})\leftarrow f)_j$,或者$((\alpha\rightarrow\bar{f})\leftarrow f)_i\subseteq((\alpha\rightarrow\bar{f})\leftarrow f)_j$,则有 $\mathrm{card}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j})\leq\mathrm{card}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i})$,$\mathrm{GRD}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j})\leq\mathrm{GRD}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i})$.由定义 1.2 得到:$\mathrm{CHV}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j})\leq\mathrm{CHV}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i})$.由定义 1.1,有 $\mathrm{MID}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i})\leq\mathrm{MID}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j})$;或者 $\mathrm{MID}(\mathrm{IND}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}))\leq\mathrm{MID}(\mathrm{IND}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}))$.

2° 因为$((\alpha\rightarrow\bar{f})\leftarrow f)_i\Leftrightarrow((\alpha\rightarrow\bar{f})\leftarrow f)_j$,或者$((\alpha\rightarrow\bar{f})\leftarrow f)_i=((\alpha\rightarrow\bar{f})\leftarrow f)_j$,则有 $\mathrm{card}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j})=\mathrm{card}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i})$,易得(1.5).

定理 1.2(规律后件扩张规律挖掘定理) 设$((\alpha\rightarrow\bar{f})\leftarrow f)_i$,$((\alpha\rightarrow\bar{f})\leftarrow f)_j$,分别是$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$,$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}$的属性集,若$((\alpha\rightarrow\bar{f})\leftarrow f)_i\Rightarrow((\alpha\rightarrow\bar{f})\leftarrow f)_j$,则$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$,$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}\in[\mathscr{U}]$的挖掘度满足

$$\mathrm{MID}(\mathrm{IND}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}))\leq\mathrm{MID}(\mathrm{IND}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}\cup[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j})).\tag{1.6}$$

定理 1.3(规律传递规律挖掘定理)　设$((\alpha\to\bar{f})\leftarrow f)_i,((\alpha\to\bar{f})\leftarrow f)_j,((\alpha\to\bar{f})\leftarrow f)_k$分别是$[u]_{((\alpha\to\bar{f})\leftarrow f)_i},[u]_{((\alpha\to\bar{f})\leftarrow f)_j},[u]_{((\alpha\to\bar{f})\leftarrow f)_k}\in[\mathscr{U}]$的属性集,若$((\alpha\to\bar{f})\leftarrow f)_i\Rightarrow((\alpha\to\bar{f})\leftarrow f)_j$,$((\alpha\to\bar{f})\leftarrow f)_j\Rightarrow((\alpha\to\bar{f})\leftarrow f)_k$,则$[u]_{((\alpha\to\bar{f})\leftarrow f)_i},[u]_{((\alpha\to\bar{f})\leftarrow f)_j},[u]_{((\alpha\to\bar{f})\leftarrow f)_k}\in[\mathscr{U}]$的挖掘度满足

$$\mathrm{MID}(\mathrm{IND}([u]_{((\alpha\to\bar{f})\leftarrow f)_i}))\le\mathrm{MID}(\mathrm{IND}([u]_{((\alpha\to\bar{f})\leftarrow f)_j}))\le\mathrm{MID}(\mathrm{IND}([u]_{((\alpha\to\bar{f})\leftarrow f)_k})).\tag{1.7}$$

定理 1.4(规律传递–后件扩张规律挖掘定理)　设$((\alpha\to\bar{f})\leftarrow f)_i,((\alpha\to\bar{f})\leftarrow f)_j,((\alpha\to\bar{f})\leftarrow f)_k$,分别是$[u]_{((\alpha\to\bar{f})\leftarrow f)_i},[u]_{((\alpha\to\bar{f})\leftarrow f)_j},[u]_{((\alpha\to\bar{f})\leftarrow f)_k}\in[\mathscr{U}]$的属性集,若$((\alpha\to\bar{f})\leftarrow f)_i\Rightarrow((\alpha\to\bar{f})\leftarrow f)_j$,$((\alpha\to\bar{f})\leftarrow f)_j\Rightarrow((\alpha\to\bar{f})\leftarrow f)_k$,则

$$\mathrm{MID}(\mathrm{IND}([u]_{((\alpha\to\bar{f})\leftarrow f)_i}\cup[u]_{((\alpha\to\bar{f})\leftarrow f)_j}))\le\mathrm{MID}(\mathrm{IND}([u]_{((\alpha\to\bar{f})\leftarrow f)_k})).\tag{1.8}$$

定理 1.5(规律单蕴含–后件扩张单蕴含规律挖掘定理)　设$((\alpha\to\bar{f})\leftarrow f)_i,((\alpha\to\bar{f})\leftarrow f)_j,((\alpha\to\bar{f})\leftarrow f)_k,((\alpha\to\bar{f})\leftarrow f)_t$分别是$[u]_{((\alpha\to\bar{f})\leftarrow f)_i},[u]_{((\alpha\to\bar{f})\leftarrow f)_j},[u]_{((\alpha\to\bar{f})\leftarrow f)_k},[u]_{((\alpha\to\bar{f})\leftarrow f)_t}$的属性集,若$((\alpha\to\bar{f})\leftarrow f)_i\Rightarrow((\alpha\to\bar{f})\leftarrow f)_j,((\alpha\to\bar{f})\leftarrow f)_j\cup((\alpha\to\bar{f})\leftarrow f)_k\Rightarrow((\alpha\to\bar{f})\leftarrow f)_t$,则

$$\mathrm{MID}(\mathrm{IND}([u]_{((\alpha\to\bar{f})\leftarrow f)_i}\cup[u]_{((\alpha\to\bar{f})\leftarrow f)_j}))\le\mathrm{MID}(\mathrm{IND}([u]_{((\alpha\to\bar{f})\leftarrow f)_t})).\tag{1.9}$$

定理 1.2 ~ 1.5 的证明与定理 1.1 的证明相似;定理 1.2 ~ 1.5 的证明,略.

定理 1.1 ~ 1.5 给出一个共同事实:因为对规律$[u]$的属性集α中的属性删除,对属性α的属性补充,引起规律$[u]$的颗粒大小的变化,使得潜藏在$[u]$中的规律$[u]^*$从$[u]$中被挖掘.显然,规律挖掘伴随着规律的分辨,3 中给出这些讨论.

2　$(F,\bar{F})$-规律推理与规律挖掘分辨

定理 2.1(规律挖掘的 F-分辨定理)　设$((\alpha\to\bar{f})\leftarrow f)_i,((\alpha\to\bar{f})\leftarrow f)_j$分别是$[u]_{((\alpha\to\bar{f})\leftarrow f)_i}$,$[u]_{((\alpha\to\bar{f})\leftarrow f)_j}$的属性集,而且$[u]_{((\alpha\to\bar{f})\leftarrow f)_i}$的属性删除$(\alpha\to\bar{f})_i$与$[u]_{((\alpha\to\bar{f})\leftarrow f)_j}$的属性删除$(\alpha\to\bar{f})_j$满足$\mathrm{card}((\alpha\to\bar{f})_i)=\mathrm{card}((\alpha\to\bar{f})_j)$,若

$$\mathrm{card}((\alpha\to\bar{f})\leftarrow f)_i\ge\mathrm{card}((\alpha\to\bar{f})\leftarrow f)_j,\tag{2.1}$$

则$[u]_{((\alpha\to\bar{f})\leftarrow f)_i}$关于$[u]_{((\alpha\to\bar{f})\leftarrow f)_j}$$F$-分辨,而且

$$\underset{F}{\mathrm{DIS}}([u]_{((\alpha\to\bar{f})\leftarrow f)_i},[u]_{((\alpha\to\bar{f})\leftarrow f)_j}).\tag{2.2}$$

证明　因为对$[u]_{((\alpha\to\bar{f})\leftarrow f)_i}$的属性删除$(\alpha\to\bar{f})_i$与对$[u]_{((\alpha\to\bar{f})\leftarrow f)_j}$的属性删除$(\alpha\to\bar{f})_j$满足$\mathrm{card}((\alpha\to\bar{f})_i)=\mathrm{card}((\alpha\to\bar{f})_j)$;对$[u]_{((\alpha\to\bar{f})\leftarrow f)_i}$的属性补充$((\alpha\to\bar{f})\leftarrow f)_i$与对$[u]_{((\alpha\to\bar{f})\leftarrow f)_j}$的属性补充$((\alpha\to\bar{f})\leftarrow f)_j$满足$\mathrm{card}((\alpha\to\bar{f})\leftarrow f)_i\ge\mathrm{card}((\alpha\to\bar{f})\leftarrow f)_j$,则有$\mathrm{GRD}([u]_{((\alpha\to\bar{f})\leftarrow f)_i})\le\mathrm{GRD}([u]_{((\alpha\to\bar{f})\leftarrow f)_j})$.因此,$[u]_{((\alpha\to\bar{f})\leftarrow f)_i},[u]_{((\alpha\to\bar{f})\leftarrow f)_j}$,在元素迁移$f\in F$的条件,关于粒度可分辨,则有(2.2).这里,DIS 是 discernibility 的简写.

定理 2.2(规律挖掘的 $\bar{F}$-分辨定理)　设$((\alpha\to\bar{f})\leftarrow f)_i,((\alpha\to\bar{f})\leftarrow f)_j$分别是$[u]_{((\alpha\to\bar{f})\leftarrow f)_i}$,$[u]_{((\alpha\to\bar{f})\leftarrow f)_j}$的属性集,而且$[u]_{((\alpha\to\bar{f})\leftarrow f)_i}$的属性补充$(\alpha\leftarrow f)_i$与$[u]_{((\alpha\to\bar{f})\leftarrow f)_j}$的属性补充$(\alpha\leftarrow f)_j$满足$\mathrm{card}((\alpha\leftarrow f)_i)=\mathrm{card}((\alpha\leftarrow f)_j)$,若

$$\mathrm{card}((\alpha\to\bar{f})\leftarrow f)_i\ge\mathrm{card}((\alpha\to\bar{f})\leftarrow f)_j,\tag{2.3}$$

则$[u]_{((\alpha\to\bar{f})\leftarrow f)_i}$关于$[u]_{((\alpha\to\bar{f})\leftarrow f)_j}$$\bar{F}$-分辨,而且

$$\underset{\bar{F}}{\mathrm{DIS}}([u]_{((\alpha\to\bar{f})\leftarrow f)_i},[u]_{((\alpha\to\bar{f})\leftarrow f)_j}).\tag{2.4}$$

证明与定理 2.1 类似,证明略.

定理 2.3(规律挖掘的 F-非分辨定理)　设$((\alpha\to\bar{f})\leftarrow f)_i,((\alpha\to\bar{f})\leftarrow f)_j$,分别是$[u]_{((\alpha\to\bar{f})\leftarrow f)_i}$,$[u]_{((\alpha\to\bar{f})\leftarrow f)_j}$的属性集,而且$[u]_{((\alpha\to\bar{f})\leftarrow f)_i}$的属性删除$(\alpha\to\bar{f})_i$与$[u]_{((\alpha\to\bar{f})\leftarrow f)_j}$的属性删除$(\alpha\to\bar{f})_j$满足

$\mathrm{card}((\alpha\rightarrow\bar{f})_i)=\mathrm{card}((\alpha\rightarrow\bar{f})_j)$,若

$$\mathrm{card}((\alpha\rightarrow\bar{f})\leftarrow f)_i=\mathrm{card}((\alpha\rightarrow\bar{f})\leftarrow f)_j, \tag{2.5}$$

则$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$关于$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}$$F$-非分辨,而且

$$\underset{F}{\mathrm{IND}}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i},[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}). \tag{2.6}$$

定理 2.4 (规律挖掘的 $\bar{F}$-非分辨定理) 设$((\alpha\rightarrow\bar{f})\leftarrow f)_i$,$((\alpha\rightarrow\bar{f})\leftarrow f)_j$ 分别是$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$,$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}$的属性集,而且$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$的属性补充$(\alpha\leftarrow f)_i$与$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}$的属性补充$(\alpha\leftarrow f)_j$满足$\mathrm{card}((\alpha\leftarrow f)_i)=\mathrm{card}((\alpha\leftarrow f)_j)$,若

$$\mathrm{card}((\alpha\rightarrow\bar{f})\leftarrow f)_i=\mathrm{card}((\alpha\rightarrow\bar{f})\leftarrow f)_j, \tag{2.7}$$

则$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i}$关于$[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}$$\bar{F}$-非分辨,而且

$$\underset{\bar{F}}{\mathrm{IND}}([u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_i},[u]_{((\alpha\rightarrow\bar{f})\leftarrow f)_j}). \tag{2.8}$$

定理2.3~2.4分别是直接的事实,定理2.3,2.4的证明略.

利用1,2的讨论,得到

$(F,\bar{F})$-规律推理的规律挖掘原理

潜藏在规律$[u]$中的规律$[u]^*$从$[u]$中被挖掘,规律$[u]^*$的属性集$\alpha^*=((\alpha\rightarrow\bar{f})\leftarrow f)$与规律$[u]$的属性集$\alpha$满足$\alpha\Rightarrow\alpha^*$;$[u]^*$从$[u]$中被挖掘依赖于属性集$\alpha$中的属性删除与属性补充.

$(F,\bar{F})$-规律挖掘的规律分辨原理

潜藏在规律$[u]$中的规律$[u]^*$从$[u]$中被挖掘,$[u]^*$关于$[u]$可分辨,而且

$$\mathrm{DIS}([u],[u]^*),$$

必有

$$\mathrm{card}(\alpha^*)\geq\mathrm{card}(\alpha).$$

这里:α是$[u]$的属性集,α^*是$[u]^*$的属性集.

1,2中给出的结果在风险投资规律分析,系统规律故障识别中的应用与应用模型,在另文中给出这些细节,略.

3 讨论

函数单向S-粗集是依据对函数等价类(规律)$[u]$中的元素补充(等价于$[u]$的属性集α中的属性删除)被提出的[5,6];函数单向S-粗集对偶是依据对函数等价类(规律)$[u]$中的元素删除(等价于$[u]$的属性集α中的属性补充)被提出的[5,6].函数单向S-粗集,函数单向S-粗集对偶都具有函数特征,函数是一个规律.函数单向S-粗集,函数单向S-粗集对偶,对于寻找系统(投资系统,故障诊断系统,图像识别系统,通讯系统)中还没有被人们认识的规律[1~3,7]的研究,提供了一个新工具.规律挖掘是函数S-粗集中的一个新的研究方向.

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(编辑:李晓红)