

Set Theoretic Rajan Transform and its Properties

E. G. Rajan

Received: 7 December 2019 Accepted: 31 December 2019 Published: 15 January 2020

Abstract

In this paper, we describe the formulation of a novel transform called Set Theoretic Rajan Transform (STRT) which is an extension of Rajan Transform (RT). RT is a coding morphism by which a number sequence (integer, rational, real, or complex) of length equal to any power of two is transformed into a highly correlated number sequence of same length. STRT was introduced by G. Sathya. In STRT, RT is applied to a sequence of sets instead of sequences of numbers. Here the union (U) is analogous to addition (+) operation and symmetric difference (Δ) is analogous to subtraction (-). This transform satisfies some interesting set theoretic properties like Cyclic Shift Invariance, Dyadic Shift invariance, Graphical Inverse Invariance. This paper explains in detail about STRT and all of its set theoretic properties.

Index terms—

1 Introduction

In STRT, given a sequence of sets $X(n)$ of length N , which is a power of two, first it is divided into the first half and the second half each consisting of $(N/2)$ points so that the following holds good : $G(j)=X(i) \cup X(i+(N/2))$; $0 \leq j < (N/2)$; $0 \leq i < (N/2)$ $H(j)=X(i) \Delta X(i+(N/2))$; $0 \leq j < (N/2)$; $0 \leq i < (N/2)$ Now each $(N/2)$ -point segment is further divided into two half's each consisting of $(N/4)$ points so that the following holds good: $G1(k)=G(j) \cup G(j+(N/4))$; $0 \leq k < (N/4)$; $0 \leq j < (N/4)$ $G2(k)=G(j) \Delta G(j+(N/4))$; $0 \leq k < (N/4)$; $0 \leq j < (N/4)$ $H1(k)=H(j) \cup H(j+(N/4))$; $0 \leq k < (N/4)$; $0 \leq j < (N/4)$ $H2(k)=H(j) \Delta H(j+(N/4))$; $0 \leq k < (N/4)$; $0 \leq j < (N/4)$ This process is continued till no more division is possible. The total number of stages thus turns out to be $\log_2 N$. Then the signal flow graph for STRT of length eight would be of the form shown in the Fig. ??.

2 Fig. 1: Signal Flow graph of STRT

Unlike RT, duality doesn't hold good in STRT. If $X(n)$ is a set sequence of length $N=2k$, $k>0$ then its Set Theoretic Rajan Transform is denoted by $Y(k)$. Consider a set sequence $X(1)=\{1,2\}$, $X(2)=\{3,4,6\}$, $X(3)=\{4,5\}$, $X(4)=\{1,5\}$, $X(5)=\{1,4,5\}$, $X(6)=\{3,4,5\}$, $X(7)=\{2,6\}$, $X(8)=\{1,4,6\}$. Then STRT is computed as follows.

3 Input set sequence

Stage #1 Stage #2

4 c) Dyadic Shift Invariance property

The term 'dyad' refers to a group of two, and the term 'dyadic shift' to the operation of transposition of two blocks of elements in a sequence. For instance, let us take $X(n)=\{1,2\}, \{3,4,6\}, \{4,5\}, \{1,5\}, \{1,4,5\}, \{3,4,5\}, \{2,6\}, \{1,4,6\}$ and transpose its first half with the second half. The resulting sequence $Td(2)[X(n)]=\{1,4,5\}, \{3,4,5\}, \{2,6\}, \{1,4,6\}, \{1,2\}, \{3,4,6\}, \{4,5\}, \{1,5\}$ is the 2-block dyadic shifted version of $X(n)$. The symbol $Td(2)$ denotes the 2-block dyadic shift operator. In the same manner, we obtain $Td(4)[Td(2)[X(n)]] = \{2,6\}, \{1,4,6\}, \{1,4,5\}, \{3,4,5\}, \{4,5\}, \{1,5\}, \{1,2\}, \{3,4,6\}$.

??, ?? and $Td(8) = Td(4)[Td(2)[X(n)]] = \{1,4,6\}, \{2,6\}, \{3,4,5\}, \{1,4,5\}, \{1,5\}, \{4,5\}, \{3,4,6\}, \{1,2\}$. One can easily verify that all these dyadic shifted sequences have the same $Y(k)$, that is, $\{1,2,3,4,5,6\}, \{2,3\}, \{1,3,6\}, \{3,6\}, \{2,4,5,6\}, \{2\}, \{4,6\}, \{4,6\}$. There is yet another way of dyadic shifting input sequence $X(n)$ to $Td(2)$ $??Td(4) ??Td(8)[X(n)]$. Let us take $X(n) = \{1,2\}, \{3,4,6\}, \{4,5\}, \{1,5\}, \{1,4,5\}, \{3,4,5\}, \{2,6\}, \{1,4,6\}$ and

obtain following dyadic shifts: $Td(8)[X(n)] = \{3,4,6\}, \{1,2\}, \{1,5\}, \{4,5\}, \{3,4,5\}, \{1,4,5\}, \{1,4,6\}, \{2,6\}$ $Td(4)$
 $??Td(8)[X(n)] = \{1,5\}, \{4,5\}, \{3,4,6\}, \{1,2\}, \{1,4,6\}, \{2,6\}, ??007B$
 $??, ??, ??$ and $Td(2) ??Td(4) ??Td(8)[X(n)] = \{1,4,6\}, \{2,6\}, \{3,4,5\}, \{1,4,5\}, \{1,5\}, \{4,5\}, \{3,4,6\},$
 $\{1,2\}$. Note that $Td(2) ??Td(4) ??Td(8) [X(n)] = Td(8) ??Td(4) [Td(2)[X(n)]]$. One can easily verify from the
above that other than $Td(4)[Td(2)[X(n)]]$ and $Td(8)[X(n)]$, all other dyadically permuted sequences fall under the
category of the cyclic permutation class of $X(n)$ and $??-1(n)$. This amounts to saying that the cyclic permutation
class of $X(n)$ has eight non-repeating independent sequences, that of $X-1(n)$ has eight non-repeating independent
sequences and the dyadic permutation classes of $X(n)$ has two non-repeating independent sequences. To conclude,
all these 18 sequences could be seen to have the same $Y(k)$. Set Theoretic Rajan Transform has many emerging
applications. It can be used as a powerful tool in encrypting digital (color) images. It has many other applications
in domains like Signal Processing and Higher Order Mathematics.

5 III. Application of strt in the Study of

Extended Topological Filters Defined Over a Finite Set

Consider a finite set $X = \{a, b, c\}$. Then its power set is $??007B\{\{a\}, \{b\}, \{c\}, \{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}\}$. One
can construct a filter set F whose elements satisfy the following property: 'Any element of F ensures the presence
of all its super sets present in the power set of X . For example consider a set $X = \{a, b, c\}$. The power set is
 $??007B\{\{a\}, \{b\}, \{c\}, \{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}\}$. The set $F = \{\{a\}, \{a, b\}, \{a, c\}, \{a, b, c\}\}$ is a valid topological
filter set since every element in F ensures the presence of all its super sets. One can construct 18 such topological
filters from the ground set X as shown in table ??.

Table ??: List of topological filters from $X = \{a, b, c\}$

6 Filters

Filter Contents Cardinality $??007B\{\{b\}, \{c\}, \{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}\}$ 7 F2 $\{\{a\}, \{b\}, \{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}\}$
6 F3 $\{\{a\}, \{c\}, \{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}\}$ 6 F4 $\{\{b\}, \{c\}, \{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}\}$ 6 F5
 $\{\{a\}, \{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}\}$ 5 F6 $\{\{b\}, \{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}\}$ 5 F7 $\{\{c\}, \{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}\}$
5 F8 $\{\{a\}, \{a, b\}, \{a, c\}, \{a, b, c\}\}$ 4 F9 $\{\{b\}, \{a, b\}, \{b, c\}, \{a, b, c\}\}$ 4 F10 $\{\{c\}, \{a, c\}, \{b, c\}, \{a, b, c\}\}$ 4 F11
 $\{\{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}\}$ 4 F12 $\{\{a, b\}, \{a, c\}, \{a, b, c\}\}$ 3 F13 $\{\{a, b\}, \{b, c\}, \{a, b, c\}\}$ 3 F14 $\{\{a, c\}, \{b, c\}, \{a, b, c\}\}$
3 F15 $\{\{a, b\}, \{a, b, c\}\}$ 2 F16 $\{\{a, c\}, \{a, b, c\}\}$ 2 F17 $\{\{b, c\}, \{a, b, c\}\}$ 2 F18 $\{\{a, b, c\}\}$ 1

7 F1

8 Lattice of topological filters

The lattice $<?, ?>$ is constructed as given in Fig. 2 whose elements are 18 topological filters defined over the
ground set $X = \{a, b, c\}$. Note that the symbol ? denotes the partial order relation of 'subset of'. To apply STRT
to a filter chain, the length of the chain should be a power of 2. The length of the chain in this case is 7. So
the null set $\{\}$ is considered as the eighth filter as it is a subset of any set. By applying STRT to these 48 filter
chains, we get their corresponding spectra. Table 2 gives the STRT spectra of all 48 linear filter chains. ??1

$\{\{a\}, ??007B$
 $??007B$
 $??, ??007B$
 $??007B$
 $??, ??007B$
 $??, ??\}$ F18 $\{\{a, ??, ??\}\}$ $\{\{a\}, ??007B$
 $??, ??007B$
 $??, ??007B$
 $??\}$ $\{\{b\}, ??007B$
 $??007B$
 $??, ??007B$
 $??\}$ $\{\{a\}, ??007B$
 $??007B$
 $??007B$
 $??, ??007B$
 $??, ??007B$
 $??, ??\}$ $??007B$
 $??, ??007B$
 $??, ??\}$ $\{\{a\}, ??007B$
 $??007B$
 $??, ??007B$

101 ??, ??} {a}, ??007B
102 ??007B
103 ??}, ??007B
104 ??, ??} Filter chain # 4 and its STRT spectrum F1 {a}, ??007B
105 ??007B
106 ??007B
107 ??}, ??007B
108 ??}, ??007B
109 ??}, ??007B
110 ??, ??} {a}, ??007B
111 ??007B
112 ??007B
113 ??}, ??007B
114 ??}, ??007B
115 ??}, ??007B
116 ??, ??} {a}, ??007B
117 ??007B
118 ??007B
119 ??}, ??007B
120 ??}, ??007B
121 ??}, ??007B
122 ??, ??} {a}, ??007B
123 ??007B
124 ??007B
125 ??}, ??007B
126 ??}, ??007B
127 ??}, ??007B
128 ??, ??} F2 {a}, ??007B
129 ??007B
130 ??}, ??007B
131 ??}, ??007B
132 ??}, ??007B
133 ??, ??} {a}, ??007B
134 ??007B
135 ??}, ??007B
136 ??}, ??007B
137 ??}, ??007B
138 ??, ??} {a}, ??007B
139 ??007B
140 ??}, ??007B
141 ??}, ??007B
142 ??}, ??007B
143 ??, ??} {c} F5 {a}, ??007B
144 ??}, ??007B
145 ??}, ??007B
146 ??}, ??007B
147 ??, ??} {a}, ??007B
148 ??}, ??007B
149 ??}, ??007B
150 ??}, ??007B
151 ??, ??} {b}, ??007B{a}, ??007B
152 ??007B{11 {a, ??}, ??007B
153 ??}, ??007B
154 ??}, ??007B
155 ??, ??} {a, ??}, ??007B
156 ??}, ??007B
157 ??}, ??007B
158 ??, ??} {a}, ??007B{a}, ??007B{12 {a, ??}, ??007B
159 ??}, ??007B
160 ??, ??} {a}, ??007B
161 ??007B
162 ??007B
163 ??} {a}, ??007B

164 ??007B
165 ??007B
166 ??}, ??007B
167 ??}, ??007B
168 ??} {{a}, ??007B
169 ??007B
170 ??007B
171 ??}, ??007B
172 ??}, ??007B
173 ??}, ??007B
174 ??, ??} F16 {{a, ??}, ??007B
175 ??, ??} {{a}, ??007B
176 ??007B
177 ??}, ??007B
178 ??} {{a}, ??007B
179 ??007B
180 ??}, ??007B
181 ??}, ??007B
182 ??}, ??007B
183 ??, ??} {{c}, ??007B
184 ??, ??} F18 {{a, ??, ??} {{a}, ??007B
185 ??}, ??007B
186 ??}, ??007B
187 ??} {{b}, ??007B
188 ??007B
189 ??}, ??007B
190 ??} {{a}, ??007B
191 ??007B
192 ??007B
193 ??}, ??007B
194 ??}, ??007B
195 ??, ??}, ??007B
196 ??}, ??007B
197 ??}, ??007B
198 ??, ??} {{a}, ??007B
199 ??007B
200 ??}, ??007B
201 ??, ??} {{a}, ??007B
202 ??007B
203 ??}, ??007B
204 ??, ??} F5 {{a}, ??007B
205 ??}, ??007B
206 ??}, ??007B
207 ?? }, ??007B
208 ??, ??} {{a}, ??007B
209 ??}, ??007B
210 ??}, ??007B
211 ??}, ??007B
212 ??, ??} {{b}, ??007B{{a}, ??007B
213 ??007B{11 {{a, ??}, ??007B
214 ??}, ??007B
215 ??}, ??007B
216 ??, ??} {{a, ??}, ??007B
217 ??}, ??007B
218 ??}, ??007B
219 ??, ?? } {{a}, ??007B{{a}, ??007B{13 {{a, ??}, ??007B
220 ??}, ??007B
221 ??, ??} {{a}, ??007B
222 ??007B
223 ??007B
224 ??} {{a}, ??007B
225 ??007B
226 ??007B

227 ??}, ??007B
 228 ?? }, ??007B
 229 ??}} {{a}, ??007B
 230 ??007B
 231 ??007B
 232 ??}, ??007B
 233 ??}, ??007B
 234 ??}, ??007B
 235 ??, ??}} F17 {{b, ??}, ??007B
 236 ??, ??}} {{a}, ??007B
 237 ??007B
 238 ??}, ??007B
 239 ??}} {{a}, ??007B
 240 ??007B
 241 ??}, ??007B
 242 ??}, ??007B
 243 ??}, ??007B
 244 ??, ??}} {{c}, ??007B
 245 ??, ??}} F18 {{a, ??, ??}} {{a}, ??007B
 246 ??}, ??007B
 247 ??}, ??007B
 248 ??}} {{b}, ??007B
 249 ??007B
 250 ??}, ??007B
 251 ??}} {{a}, ??007B
 252 ??007B
 253 ??007B
 254 ??}, ??007B
 255 ??}, ??007B
 256 ??, ??}, ??007B
 257 ??}, ??007B
 258 ??}, ??007B
 259 ??, ?? }} {{a}, ??007B
 260 ??007B
 261 ??}, ??007B
 262 ??, ??}} {{a}, ??007B
 263 ??007B
 264 ??}, ??007B
 265 ??, ??}} Filter chain # 7 and its STRT spectrum ??007B{{b},{c},{a,b },{a,c}, {b,c},{a,b,c}}
 266 {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c }, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c},
 267 {b,c},{a,b,c}} F2 {{a},{b},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{a,b},{a,c},
 268 {b,c},{a,b,c}} {{c}} F5 {{a},{a,b},{a,c},{b,c}, {a,b,c}} {{a},{a,b},{a,c},{b,c}, {a,b,c}} {{b},{c}} {{a},{b},{c}}
 269 F11 {{a,b},{a,c},{b,c},{a,b,c }} {{a,b},{a,c},{b,c},{a,b,c }} {{a},{b}} {{a},{c}} F14 {{a,c},{b,c},{a,b,c}}
 270 {{a},{b},{c},{a,b}} {{a},{b},{c},{a,b},{a,c },{b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} F16
 271 {{a,c},{a,b,c}} {{a},{b},{a,b},{b,c}} {{a},{b},{a,b},{a,c},{b, c}, {a,b,c}} {{c},{a,b,c}} F18 {{a,b,c}}
 272 {{a},{a,b},{a,c},{b,c}} {{b},{c},{a,c},{b,c}} {{a},{b},{c},{a,c},{b,c}, {a,b,c}} -{?} {{a,b},{a,c},{b,c},{a,b,c}
 273 }} {{a},{b},{a,c},{a,b,c}} {{a},{c},{b,c},{a,b,c}} Global Journal of Computer Science and Technology

274 9 F1

275 Volume XX Issue I Version I 59 Year 2020

276 10 () D

277 Filter chain # 8 and its STRT spectrum Filter chain # 9 and its STRT spectrum Filter chain
 278 # 10 and its STRT spectrum ??007B{{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c},
 279 {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a ,c}, {b,c},{a,b,c}} F2
 280 {{a},{b},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{a,b},{a,c}, {b,c},{a,b,c}}
 281 {{c}} F5 {{a},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{a,b},{a,c},{b,c}, {a,b,c}} {{b},{c}} {{a},{b},{c}} F1 1
 282 {{a,b},{a,c},{b,c},{a,b,c }} {{a,b},{a,c},{b,c},{a,b,c }} {{a},{b}} {{a},{c}} F1 4 {{a,c},{b,c},{a,b,c}}
 283 {{a},{b},{c},{a,b}} {{a},{b},{c},{a,b},{a,c},{b,c }} {{a},{b},{c},{a,b},{a ,c}, {b,c},{a,b,c}} F1 7
 284 {{b,c},{a,b,c}} {{a},{b},{a,b},{a,c}} {{a},{b},{a,b},{a,c},{b,c}, {a,b,c}} {{c},{a,b,c}} F1 8 {{a,b,c}}
 285 {{a},{a,b},{a,c},{b,c}} {{b},{c},{a,c},{b,c}} {{a},{b},{c},{a,c},{b ,c}, {a,b,c}} -{?} {{a,b},{a,c},{b,c},{a,b,c}
 286 }} {{a},{b},{b,c},{a,b,c}} {{a},{c},{a,c},{a,b,c }} F1 {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}}

```

350 {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}}
351 F4 {{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{b},{c},{a,b},{a,c},
352 {b,c},{a,b,c}} {{a}} F6 {{b},{a,b},{a,c},{b,c}, {a,b,c}} {{b},{a,b},{a,c},{b,c}, {a,b,c}} {{a},{c}}
353 {{a},{b},{c}} F11 {{a,b},{a,c},{b,c},{a,b,c}} {{a,b},{a,c},{b,c},{a,b,c}} {{b},{c}} {{a},{b}} F13
354 {{a,b},{b,c},{a,b,c}} {{a},{b},{c},{a,c}} {{a},{b},{c},{a,b},{a,c}, {b,c}} {{a},{b},{c},{a,b},{a,c},
355 {b,c},{a,b,c}} F17 {{b,c},{a,b,c}} {{b},{c},{a,b},{a,c}} {{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{a,b,c}}
356 F18 {{a,b,c}} {{b},{a,b},{a,c},{b,c}} {{a},{c},{a,b},{b,c}} {{a},{b},{c},{a,b},{b,c}, {a,b,c}} -{?}
357 {{a,b},{a,c},{b,c},{a,b,c}} {{b},{c},{b,c},{a,b,c}} {{a},{b},{a,b},{a,b,c}} Filter chain # 37 and its STRT
358 spectrum ??007B{ ??007B
359 ??007B
360 ??007B
361 ??, ??007B
362 ??, ??007B
363 ??, ??007B
364 ??, ??} {{a}, ??007B
365 ??007B
366 ??007B
367 ??, ??007B
368 ??, ??007B
369 ??, ??007B
370 ??, ??} {{a}, ??007B
371 ??007B
372 ??007B
373 ??, ??007B
374 ??, ??007B
375 ??, ??007B
376 ??, ??} {{a}, ??007B
377 ??007B
378 ??007B
379 ??, ??007B
380 ??, ??007B
381 ??, ??007B
382 ??, ??} F4 {{b}, ??007B
383 ??007B
384 ??, ??007B
385 ??, ??007B
386 ??, ??007B
387 ??, ??} {{b}, ??007B
388 ??007B
389 ??, ??007B
390 ??, ??007B
391 ??, ??007B
392 ??, ??} {{b}, ??007B
393 ??007B
394 ??, ??007B
395 ??, ??007B
396 ??, ??007B
397 ??, ??} {{a}} F6 {{b}, ??007B
398 ??, ??007B
399 ??, ??007B
400 ??, ??007B
401 ??, ??} {{b}, ??007B
402 ??, ??007B
403 ??, ??007B
404 ??, ??007B
405 ??, ??} {{a}, ??007B{a}, ??007B
406 ??007B{11 {{a}, ??}, ??007B
407 ??, ??007B
408 ??, ??007B
409 ??, ??} {{a}, ??}, ??007B
410 ??, ??007B
411 ??, ??007B
412 ??, ?? } {{b}, ??007B{a}, ??007B{14 {{a}, ??}, ??007B

```

413 ??}, ??007B
414 ??, ??} {{a}, ??007B
415 ??007B
416 ??007B
417 ??} {{a}, ??007B
418 ??007B
419 ??007B
420 ??}, ??007B
421 ??}, ??007B
422 ??} {{a}, ??007B
423 ??007B
424 ??007B
425 ??}, ??007B
426 ??}, ??007B
427 ??}, ??007B
428 ??, ??} F16 {{a}, ??}, ??007B
429 ??, ??} {{b}, ??007B
430 ??007B
431 ??}, ??007B
432 ??} {{b}, ??007B
433 ??007B
434 ??}, ??007B
435 ??}, ??007B
436 ??}, ??007B
437 ??, ??} {{a}, ??007B
438 ??, ??} F18 {{a}, ??, ??} {{b}, ??007B
439 ??}, ??007B
440 ??}, ??007B
441 ??} {{a}, ??007B
442 ??007B
443 ??}, ??007B
444 ??} {{a}, ??007B
445 ??007B
446 ??007B
447 ??}, ??007B
448 ??}, ??007B
449 ??, ??}, ??007B
450 ??}, ??007B
451 ??}, ??007B
452 ??, ?? } {{b}, ??007B
453 ??007B
454 ??}, ??007B
455 ??, ??} {{a}, ??007B
456 ??007B
457 ??}, ??007B
458 ??, ??} Filter chain # 38 and its STRT spectrum F1 {{a}, ??007B
459 ??007B
460 ??007B
461 ??}, ??007B
462 ??}, ??007B
463 ??}, ??007B
464 ??, ??} {{a}, ??007B
465 ??007B
466 ??007B
467 ??}, ??007B
468 ??}, ??007B
469 ??}, ??007B
470 ??, ??} {{a}, ??007B
471 ??007B
472 ??007B
473 ??}, ??007B
474 ??}, ??007B
475 ??}, ??007B

476 ??, ??} {{a}, ??007B
477 ??007B
478 ??007B
479 ??}, ??007B
480 ??}, ??007B
481 ??}, ??007B
482 ??, ??} F4 {{b}, ??007B
483 ??007B
484 ??}, ??007B
485 ??}, ??007B
486 ??}, ??007B
487 ??, ??} {{b}, ??007B
488 ??007B
489 ??}, ??007B
490 ??}, ??007B
491 ??}, ??007B
492 ??, ??} {{b}, ??007B
493 ??007B
494 ??}, ??007B
495 ??}, ??007B
496 ??}, ??007B
497 ??, ??} {{a}} F6 {{b}, ??007B
498 ??}, ??007B
499 ??}, ??007B
500 ??}, ??007B
501 ??, ??} {{b}, ??007B
502 ??}, ??007B
503 ??}, ??007B
504 ??}, ??007B
505 ??, ??} {{a}, ??007B{{a}, ??007B
506 ??007B{11 {{a}, ??}, ??007B
507 ??}, ??007B
508 ??}, ??007B
509 ??, ??} {{a}, ??}, ??007B
510 ??}, ??007B
511 ??}, ??007B
512 ??, ??} {{b}, ??007B{{a}, ??007B{14 {{a}, ??}, ??007B
513 ??}, ??007B
514 ??, ??} {{a}, ??007B
515 ??007B
516 ??007B
517 ??} {{a}, ??007B
518 ??007B
519 ??007B
520 ??}, ??007B
521 ??}, ??007B
522 ??} {{a}, ??007B
523 ??007B
524 ??007B
525 ??}, ??007B
526 ??}, ??007B
527 ??}, ??007B
528 ??, ??} F17 {{b}, ??}, ??007B
529 ??, ??} {{b}, ??007B
530 ??007B
531 ??}, ??007B
532 ??} {{b}, ??007B
533 ??007B
534 ??}, ??007B
535 ??}, ??007B
536 ??}, ??007B
537 ??, ??} {{a}, ??007B
538 ??, ??} F18 {{a}, ??, ??} {{b}, ??007B

539 ??}, ??007B
540 ??}, ??007B
541 ??}} {{a}, ??007B
542 ??007B
543 ??}, ??007B
544 ??}} {{a}, ??007B
545 ??007B
546 ??007B
547 ??}, ??007B
548 ??}, ??007B
549 ??, ??}, ??007B
550 ??}, ??007B
551 ??}, ??007B
552 ??, ??}} {{b}, ??007B
553 ??007B
554 ??}, ??007B
555 ??, ??}} {{a}, ??007B
556 ??007B
557 ??}, ??007B
558 ??, ??}} Global Journal of Computer Science and Technology

11 F1

559 F1F1
560
561 Volume XX Issue I Version I 69 Year 2020

12 () D

562
563 Filter chain # 39 and its STRT spectrum ??007B{{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c},
564 {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}}
565 F4 {{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{b},{c},{a,b},{a,c},
566 {b,c},{a,b,c}} {{a}} F6 {{b},{a,b},{a,c},{b,c}, {a,b,c}} {{b},{a,b},{a,c},{b,c}, {a,b,c}} {{a},{c}}
567 {{a},{c},{a,c}} F9 {{b},{a,b},{b,c},{a,b,c}} {{b},{a,b},{b,c},{a,b,c}} {{c},{a,c}} {{a},{a,c}} F13
568 {{a,b},{b,c},{a,b,c}} {{a},{b},{c},{a,c}} {{a},{b},{c},{a,b}, {a,c},{b,c}} {{a},{b},{c},{a,b},{a,c},
569 {b,c},{a,b,c}} F15 {{a,b},{a,b,c}} {{b},{c},{a,c},{b,c}} {{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{a,b,c}}
570 F18 {{a,b,c}} {{b},{a,b},{a,c},{b,c}} {{a},{c},{a,b},{b,c}} {{a},{c},{a,b},{a,c},{b,c}, {a,b,c}} -{?
571 {{b},{a,b},{b,c},{a,b,c}} {{c},{a,b},{a,c},{a,b,c}} {{a},{a,c},{b,c},{a,b,c}} Filter chain #40 and its
572 STRT spectrum Filter chain # 41 and its STRT spectrum ??007B{ ??007B
573 ??007B
574 ??007B
575 ??}, ??007B
576 ??}, ??007B
577 ??}, ??007B
578 ??, ??}} {{a}, ??007B
579 ??007B
580 ??007B
581 ??}, ??007B
582 ??}, ??007B
583 ??}, ??007B
584 ??, ??}} {{a}, ??007B
585 ??007B
586 ??007B
587 ??}, ??007B
588 ??}, ??007B
589 ??}, ??007B
590 ??, ??}} {{a}, ??007B
591 ??007B
592 ??007B
593 ??}, ??007B
594 ??}, ??007B
595 ??}, ??007B
596 ??, ??}} F4 {{b}, ??007B
597 ??007B
598 ??}, ??007B

599 ??}, ??007B
600 ??}, ??007B
601 ??, ??} {{b}, ??007B
602 ??007B
603 ??}, ??007B
604 ??}, ??007B
605 ??}, ??007B
606 ??, ??} {{b}, ??007B
607 ??007B
608 ??}, ??007B
609 ??}, ??007B
610 ??}, ??007B
611 ??, ??} {{a}} F7 {{c}, ??007B
612 ??}, ??007B
613 ??}, ??007B
614 ??}, ??007B
615 ??, ??} {{c}, ??007B
616 ??}, ??007B
617 ??}, ??007B
618 ??}, ??007B
619 ??, ??} {{a}, ??007B{{a}, ??007B
620 ??007B{11 {{a, ??}, ??007B
621 ??}, ??007B
622 ??}, ??007B
623 ??, ??} {{a, ??}, ??007B
624 ??}, ??007B
625 ??}, ??007B
626 ??, ??} {{b}, ??007B{{a}, ??007B{12 {{a, ??}, ??007B
627 ??}, ??007B
628 ??, ??} {{a}, ??007B
629 ??007B
630 ??007B
631 ??} {{a}, ??007B
632 ??007B
633 ??007B
634 ??}, ??007B
635 ??}, ??007B
636 ??} {{a}, ??007B
637 ??007B
638 ??007B
639 ??}, ??007B
640 ??}, ??007B
641 ??}, ??007B
642 ??, ??} F15 {{a, ??}, ??007B
643 ??, ??} {{b}, ??007B
644 ??007B
645 ??}, ??007B
646 ??} {{b}, ??007B
647 ??007B
648 ??}, ??007B
649 ??}, ??007B
650 ??}, ??007B
651 ??, ??} {{a}, ??007B
652 ??, ??} F18 {{a, ??, ??} {{c}, ??007B
653 ??}, ??007B
654 ??}, ??007B
655 ??} {{a}, ??007B
656 ??007B
657 ??}, ??007B
658 ??} {{a}, ??007B
659 ??007B
660 ??007B
661 ??}, ??007B

```

662 ??}, ??007B
663 ??, ??}, ??007B
664 ??}, ??007B
665 ??}, ??007B
666 ??, ??}} {{b}}, ??007B
667 ??007B
668 ??}, ??007B
669 ??, ??}} {{a}}, ??007B
670 ??007B
671 ??}, ??007B
672 ??, ??}} Filter chain # 42 and its STRT spectrum F1 {{a}}, ??007B
673 ??007B
674 ??007B
675 ??}, ??007B
676 ??}, ??007B
677 ??}, ??007B
678 ??, ??}} {{a}}, ??007B
679 ??007B
680 ??007B
681 ??}, ??007B
682 ??}, ??007B
683 ??}, ??007B
684 ??, ??}} {{a}}, ??007B
685 ??007B
686 ??007B
687 ??}, ??007B
688 ??}, ??007B
689 ??}, ??007B
690 ??, ??}} {{a}}, ??007B
691 ??007B
692 ??007B
693 ??}, ??007B
694 ??}, ??007B
695 ??}, ??007B
696 ??, ??}} F4 {{b}}, ??007B
697 ??007B
698 ??}, ??007B
699 ??}, ??007B
700 ??}, ??007B
701 ??, ??}} {{b}}, ??007B
702 ??007B
703 ??}, ??007B
704 ??}, ??007B
705 ??}, ??007B
706 ??, ??}} {{b}}, ??007B
707 ??007B
708 ??}, ??007B
709 ??}, ??007B
710 ??}, ??007B
711 ?? ??12 {{a,b},{a,c},{a,b,c}} {{a},{b},{c},{b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c}} {{a},{b},{c},{a,b},{a,c},
712 {b,c},{a,b,c}} F16 {{a,c},{a,b,c}} {{b},{c},{a,b},{b,c}} {{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{a,b,c}}
713 F18 {{a,b,c}} {{c},{a,b},{a,c},{b,c}} {{a},{b},{a,b},{a,c}} {{a},{b},{c},{a,b},{a,c}, {a,b,c}} -
714 {?} {{a,b},{a,c},{b,c}, {a,b,c}} {{b},{c},{a,c},{a,b,c}} {{a},{c},{a,b},{a,b,c}} Filter chain #
715 43 and its STRT spectrum ??007B{{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c},
716 {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} F4
717 {{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{b},{c},{a,b},{a,c}, {b,c},{a,b,
718 ??7 {{c},{a,b},{a,c},{b,c}, {a,b,c}} {{c},{a,b},{a,c},{b,c}, {a,b,c}} {{a},{b}} {{a},{b},{c}} F11
719 {{a,b},{a,c},{b,c},{a,b,c}} {{a,b},{a,c},{b,c},{a,b,c}} {{b},{c}} {{a},{c}} F13 {{a,b},{b,c},{a,b,c}}
720 {{a},{b},{c},{a,c}} {{a},{b},{c},{a,b},{a,c}, {b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} F17
721 {{b,c},{a,b,c}} {{b},{c},{a,b},{a,c}} {{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{a,b,c}} F18
722 {{a,b,c}} {{c},{a,b},{a,c},{b,c}} {{a},{b},{a,b},{b,c}} {{a},{b},{c},{a,b},{b,c}, {a,b,c}} -{?}
723 {{a,b},{a,c},{b,c},{a,b,c}} {{b},{c},{b,c},{a,b,c}} {{a},{c},{a,b},{a,b,c}} Filter chain # 45 and its
724 STRT spectrum ??007B{{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}}

```

725 $\{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\}$ F4 $\{\{b\},\{c\},\{a,b\},\{a,c\},$
726 $\{b,c\},\{a,b,c\}\} \{\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\}\}$ F7
727 $\{\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\},\{b\}\} \{\{a\},\{b\},\{c\}\}$ F11
728 $\{\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{b\},\{c\}\} \{\{a\},\{c\}\}$ F14 $\{\{a,c\},\{b,c\},\{a,b,c\}\}$
729 $\{\{a\},\{b\},\{c\},\{a,b\}\} \{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\}\} \{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\}$ F16
730 $\{\{a,c\},\{a,b,c\}\} \{\{b\},\{c\},\{a,b\},\{b,c\}\} \{\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\},\{a,b,c\}\}$ F18 $\{\{a,b,c\}\}$
731 $\{\{c\},\{a,b\},\{a,c\},\{b,c\}\} \{\{a\},\{b\},\{a,c\},\{b,c\}\} \{\{a\},\{b\},\{c\},\{a,c\},\{b,c\},\{a,b,c\}\} - \{?\} \{\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\}$
732 $\{\{b\},\{c\},\{a,c\},\{a,b,c\}\} \{\{a\},\{c\},\{b,c\},\{a,b,c\}\}$ Global Journal of Computer Science and Technology F1F1F1F1
733 Volume XX Issue I Version I 71 Year 2020

734 13 () D

735 Filter chain # 46 and its STRT spectrum ??007B $\{\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},$
736 $\{b,c\},\{a,b,c\}\} \{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\}$ F4
737 $\{\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\}$
738 $\{\{a\}\}$ F7 $\{\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\},\{b\},\{c\},\{d\},\{a,b\},\{a,c\},$
739 $\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$. One can construct a filter set F
740 whose elements satisfy the following property: 'Any element of F ensures the presence of all its super sets present
741 in the power set of X. One can construct 166 topological filters from the ground set $X = \{a,b,c,d\}$. This list is
742 given in table 2.F1

743 14 F1

744 $\{\{a\} \text{ ?? } \{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},$
745 $\{b,c\},\{a,b,c\}\} \{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\}$ F4 $\{\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\}$
746 $\{\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\}\}$ F7 $\{\{c\},\{a,b\},\{a,c\},\{b,c\},$
747 $\{a,b,c\}\} \{\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\},\{b\}\} \{\{a\},\{b\},\{a,b\}\}$ F10 $\{\{c\},\{a,c\},\{b,c\},\{a,b,c\}\}$
748 $\{\{c\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{b\},\{a,b\}\} \{\{a\},\{a,b\}\}$ F14 $\{\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\},\{b\},\{c\},\{a,b\}\}$
749 $\{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\}\} \{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\}$ F16 $\{\{a,c\},\{a,b,c\}\}$
750 $\{\{b\},\{c\},\{a,b\},\{b,c\}\} \{\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\},\{a,b,c\}\}$ F18 $\{\{a,b,c\}\} \{\{c\},\{a,b\},\{a,c\},\{b,c\}\}$
751 $\{\{a\},\{b\},\{a,c\},\{b,c\}\} \{\{a\},\{b\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} - \{?\} \{\{c\},\{a,c\},\{b,c\},\{a,b,c\}\}$
752 $\{\{b\},\{a,b\},\{a,c\},\{a,b,c\}\} \{\{a\},\{a,b\},\{b,c\},\{a,b,c\}\}$ F1 $\{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\}$
753 $\{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},$
754 $\{b,c\},\{a,b,c\}\}$ F4 $\{\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{b\},\{c\},\{a,b\},\{a,c\},$
755 $\{b,c\},\{a,b,c\}\} \{\{a\}\}$ F7 $\{\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\},\{b\}\}$
756 $\{\{a\},\{b\},\{a,b\}\}$ F10 $\{\{c\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{c\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{b\},\{a,b\}\} \{\{a\},\{a,b\}\}$ F14
757 $\{\{a,c\},\{b,c\},\{a,b,c\}\} \{\{a\},\{b\},\{c\},\{a,b\}\} \{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\}\} \{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},$
758 $\{b,c\},\{a,b,c\}\}$ F17 $\{\{b,c\},\{a,b,c\}\} \{\{b\},\{c\},\{a,b\},\{a,c\}\} \{\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{a,b,c\}\}$
759 $\{\{a\},\{a,b,c\}\}$ F18 $\{\{a,b,c\}\} \{\{c\},\{a,b\},\{a,c\},\{b,c\}\} \{\{a\},\{b\},\{a,c\},\{b,c\}\} \{\{a\},\{b\},\{a,b\},\{a,c\},\{b,c\},$
760 $\{a,b,c\}\} - \{?\} \{\{c\},\{a,c\},\{b,c\},\{a,b,c\}\} \{\{b\},\{a,b\},\{b,c\},\{a,b,c\}\} \{\{a\},\{a,b\},\{a,c\},\{a,b,c\}\} \text{ ?? } 1$
761 $\{\{a\},\{b\},\{c\},\{d\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
762 15 F2 $\{\{a\},\{b\},\{c\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
763 14 F3 $\{\{a\},\{b\},\{d\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
764 14 F4 $\{\{a\},\{c\},\{d\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
765 14 F5 $\{\{b\},\{c\},\{d\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
766 14 F6 $\{\{a\},\{b\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
767 13 F7 $\{\{a\},\{c\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
768 13 F8 $\{\{b\},\{c\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
769 13 F9 $\{\{a\},\{d\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
770 13 F10 $\{\{b\},\{d\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
771 13 F11 $\{\{c\},\{d\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
772 13 F12 $\{\{a\},\{b\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 12
773 F13 $\{\{a\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 12
774 F14 $\{\{a\},\{c\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 12 F15
775 $\{\{b\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 12 F16
776 $\{\{b\},\{c\},\{a,b\},\{a,c\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 12 F17 $\{\{c\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
777 12 F18 $\{\{a\},\{d\},\{a,b\},\{a,c\},\{a,d\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 12
778 F19 $\{\{d\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 12
779 F20 $\{\{b\},\{d\},\{a,b\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 12 F21
780 $\{\{c\},\{d\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 12 F35 $\{\{a\},\{a,b\},\{a,c\},\{a,d\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
781 10 F36 $\{\{a\},\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 10 F37 $\{\{a\},\{a,b\},\{a,c\},\{a,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
782 10 F38 $\{\{b\},\{a,b\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 10 F39 $\{\{b\},\{a,b\},\{a,d\},\{b,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
783 10 F40 $\{\{b\},\{a,b\},\{a,c\},\{b,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 10 F41 $\{\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
784 10 F42 $\{\{a,b\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 10 F43

785 $\{\{a,b\},\{a,c\},\{b,c\},b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 10 F44 $\{\{a,b\},\{a,c\},\{a,d\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 786 10 F45 $\{\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 10 F46
 787 $\{\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 10 F47 $\{\{c\},\{a,c\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 788 10 F48 $\{\{c\},\{a,c\},\{a,d\},\{b,c\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 10 F49 $\{\{c\},\{a,b\},\{a,c\},\{b,c\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 789 10 F50 $\{\{d\},\{a,c\},\{a,d\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 10 F51 $\{\{d\},\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 790 10 F52 $\{\{d\},\{a,b\},\{a,d\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 10 F53 $\{\{a\},\{a,b\},\{a,c\},\{a,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 791 9 F54 $\{\{b\},\{a,b\},\{b,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 9 F55 $\{\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 792 9 F56 $\{\{a,d\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 9 Year 2020 () D
 793 ??007B $\{\{a,d\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 9 F58 $\{\{a,c\},\{a,d\},\{b,c\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 794 9 F59 $\{\{a,c\},\{a,d\},\{b,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 9 F60 $\{\{a,b\},\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 795 9 F61 $\{\{a,b\},\{a,d\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 9 F62 $\{\{a,b\},\{a,d\},\{b,c\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 796 9 F63 $\{\{a,b\},\{a,d\},\{b,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 9 F64 $\{\{a,b\},\{a,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 797 9 F65 $\{\{a,b\},\{a,c\},\{b,c\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 9 F66 $\{\{a,b\},\{a,c\},\{b,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 798 9 F67 $\{\{a,b\},\{a,c\},\{a,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 9 F68 $\{\{a,b\},\{a,c\},\{a,d\},\{b,c\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 799 9 F69 $\{\{a,b\},\{a,c\},\{a,d\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 9 F70 $\{\{c\},\{a,c\},\{b,c\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 800 9 F71 $\{\{d\},\{a,d\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 9 F72 $\{\{a\},\{a,b\},\{a,c\},\{a,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 801 8 F73 $\{\{b\},\{a,b\},\{b,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 8 F74 $\{\{b,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 802 8 F75 $\{\{a,d\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 8 F76 $\{\{a,d\},\{b,c\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 803 8 F77 $\{\{a,d\},\{b,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 8 F78 $\{\{a,c\},\{b,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 804 8 F79 $\{\{a,c\},\{b,c\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 8 F80 $\{\{a,c\},\{a,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 805 8 F81 $\{\{a,c\},\{a,d\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 8 F82 $\{\{a,c\},\{a,d\},\{b,c\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 806 8 F83 $\{\{a,b\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 8 F84 $\{\{a,b\},\{b,c\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 807 8 F85 $\{\{a,b\},\{b,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 8 F86 $\{\{a,b\},\{a,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 808 8 F87 $\{\{a,b\},\{a,d\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 8 F88 $\{\{a,b\},\{a,d\},\{b,c\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 809 8 F89 $\{\{a,c\},\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 8 F90 $\{\{a,b\},\{a,c\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 810 8 F91 $\{\{a,b\},\{a,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 8 F92 $\{\{a,b\},\{a,c\},\{b,c\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 811 8 F93 $\{\{a,b\},\{a,c\},\{a,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 8 F94 $\{\{c\},\{a,c\},\{b,c\},\{c,d\},\{a,b,c\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 812 8 F95 $\{\{d\},\{a,d\},\{b,d\},\{c,d\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 8 F96 $\{\{a,d\},\{b,d\},\{c,d\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 813 7 F97 $\{\{a,c\},\{b,c\},\{c,d\},\{a,b,c\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 7 F98 $\{\{b,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 814 7 F99 $\{\{b,c\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 7 F100 $\{\{b,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 815 7 F101 $\{\{a,d\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 7 F102 $\{\{a,d\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 816 7 F103 $\{\{a,d\},\{b,c\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 7 F104 $\{\{a,c\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 817 7 F105 $\{\{a,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 7 F106 $\{\{a,c\},\{b,c\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 818 7 F107 $\{\{a,c\},\{a,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 7 F108 $\{\{a,b\},\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 819 7 F109 $\{\{a,b\},\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 7 F110 $\{\{a,b\},\{b,c\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 820 7 F111 $\{\{a,b\},\{a,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 7 F112 $\{\{a,b\},\{a,c\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 821 7 F113 $\{\{a,b\},\{b,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{b,c,d\},\{a,b,c,d\}\}$ 7 F114 $\{\{a,b\},\{a,c\},\{a,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{a,b,c,d\}\}$
 822 7 F115 $\{\{b,d\},\{c,d\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 6 F116 $\{\{b,c\},\{c,d\},\{a,b,c\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 823 F117 $\{\{b,c\},\{b,d\},\{a,b,c\},\{a,b,d\},\{b,c,d\},\{a,b,c,d\}\}$ 6 F118 $\{\{a,d\},\{c,d\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 824 F119 $\{\{a,d\},\{b,d\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 6 F120 $\{\{a,c\},\{c,d\},\{a,b,c\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 825 F121 $\{\{c,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 6 F122 $\{\{b,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 826 F123 $\{\{b,c\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 6 F124 $\{\{a,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 827 F125 $\{\{a,c\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 6 F126 $\{\{a,b\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 828 6 F127 $\{\{a,c\},\{b,c\},\{a,b,c\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 6 F128 $\{\{a,c\},\{a,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{a,b,c,d\}\}$
 829 F129 $\{\{a,b\},\{b,d\},\{a,b,c\},\{a,b,d\},\{b,c,d\},\{a,b,c,d\}\}$ 6 F130 $\{\{a,b\},\{b,c\},\{a,b,c\},\{a,b,d\},\{b,c,d\},\{a,b,c,d\}\}$
 830 F131 $\{\{a,b\},\{a,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{a,b,c,d\}\}$ 6 F132 $\{\{a,b\},\{a,c\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{a,b,c,d\}\}$
 831 6 F133 $\{\{b,d\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 5 F134 $\{\{c,d\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 832 5 F135 $\{\{c,d\},\{a,b,c\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 5 F136 $\{\{b,d\},\{a,b,c\},\{a,b,d\},\{b,c,d\},\{a,b,c,d\}\}$
 833 5 F137 $\{\{b,c\},\{a,b,c\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 5 F138 $\{\{b,c\},\{a,b,c\},\{a,b,d\},\{b,c,d\},\{a,b,c,d\}\}$
 834 5 F139 $\{\{a,b,c\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 5 F140 $\{\{a,d\},\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 835 5 F141 $\{\{a,d\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{a,b,c,d\}\}$ 5 F142 $\{\{a,c\},\{a,b,c\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 836 5 F143 $\{\{a,c\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{a,b,c,d\}\}$ 5 F144 $\{\{a,b\},\{a,b,c\},\{a,b,d\},\{b,c,d\},\{a,b,c,d\}\}$
 837 5 F145 $\{\{a,b\},\{a,b,c\},\{a,b,d\},\{a,c,d\},\{a,b,c,d\}\}$ 5 F146 $\{\{b,d\},\{a,b,d\},\{b,c,d\},\{a,b,c,d\}\}$
 838 4 F147 $\{\{c,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 4 F148 $\{\{b,c\},\{a,b,c\},\{b,c,d\},\{a,b,c,d\}\}$ 4 F149
 839 $\{\{a,b,c\},\{a,b,d\},\{a,c,d\},\{a,b,c,d\}\}$ 4 F150 $\{\{a,b,d\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$ 4 F151 $\{\{a,b,c\},\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 840 4 F152 $\{\{a,b,c\},\{a,b,d\},\{b,c,d\},\{a,b,c,d\}\}$ 4 F153 $\{\{a,d\},\{a,b,d\},\{a,c,d\},\{a,b,c,d\}\}$ 4 F154
 841 $\{\{a,c\},\{a,b,c\},\{a,c,d\},\{a,b,c,d\}\}$ 4 F155 $\{\{a,b\},\{a,b,c\},\{a,b,d\},\{a,b,c,d\}\}$ 4 F156 $\{\{a,c,d\},\{b,c,d\},\{a,b,c,d\}\}$
 842 3 F157 $\{\{a,b,d\},\{a,c,d\},\{a,b,c,d\}\}$ 3 F158 $\{\{a,b,d\},\{b,c,d\},\{a,b,c,d\}\}$ 3 F159 $\{\{a,b,c\},\{a,c,d\},\{a,b,c,d\}\}$
 843 3 F160 $\{\{a,b,c\},\{b,c,d\},\{a,b,c,d\}\}$ 3 F161 $\{\{a,b,c\},\{a,b,d\},\{a,b,c,d\}\}$ 3 F162 $\{\{a,c,d\},\{a,b,c,d\}\}$ 2 F163
 844 $\{\{b,c,d\},\{a,b,c,d\}\}$ 2 F164 $\{\{a,b,d\},\{a,b,c,d\}\}$ 2 F165 $\{\{a,b,c\},\{a,b,c,d\}\}$ 2 F166 $\{\{a,b,c,d\}\}$ 1 The lattice $<?,$
 845 $>>$ is constructed as given in Fig. ?? whose elements are 166 topological filters defined over the ground set $X =$
 846 $\{a,b,c,d\}$. Note that the symbol ? denotes the partial order relation of 'subset of'. One can enumerate 13,767

linear maximal filter chains from this lattice. One can compute STRT spectra for all the 13,767 linear maximal filter chains. For example, one linear maximal filter chain is considered here and its STRT shown in table ??.

15 F57

16 Observations

By applying STRT to the above maximal filter chains, we examined few pair-wise intersection properties. The level with filter of maximum cardinality is considered as Level1. By taking two random filter chains, which deviate at certain levels the following properties were observed:

Deviation in any combination of even levels results in following properties:

Union of spectra of two filter chains is same as Spectrum of Intersection of those two filter chains.

Intersection of spectra of two filter chains is same as Spectrum of Union of those two filter chains.

One can easily verify these properties by applying STRT to the below pair of filter chains: For example, let us consider $n=3$, Deviation in Level 2-F1-F2-F5-F8-F12-F15-F18 F1-F3-F5-F8-F12-F15-F18 Deviation in Level 4-F1-F3-F5-F8-F12-F15-F18 F1-F3-F5-F11-F12-F15-F18 Deviation in Level 6-F1-F4-F7-F10-F14-F16-F18 F1-F4-F7-F10-F14-F17-F18 Deviation in Level 4 and 6-F1-F2-F5-F8-F12-F15-F18 F1-F2-F5-F11-F12-F16-F18

17 Deviation in any combination of odd levels results in following properties:

Union of spectra of two filter chains is same as Spectrum of Union of those two filter chains.

Intersection of spectra of two filter chains is same as Spectrum of Intersection of those two filter chains.

One can easily verify these properties by applying STRT to the below pair of filter chains: Deviation in Level 3-F1-F3-F5-F11-F12-F15-F18 F1-F3-F7-F11-F12-F15-F18

Deviation in Level 5-F1-F2-F5-F11-F12-F16-F18 F1-F2-F5-F11-F14-F16-F18

Deviation in Level 3 and 5-F1-F3-F5-F11-F12-F15-F18 F1-F3-F7-F11-F13-F15-F18

V.

18 Concluding Remarks

All orthogonal transforms, be it continuous or discrete, are models of first order logic, that is, they have been developed in the framework of first order logic that deal with elements of sets. Alternatively, STRT is a novel concept developed in the framework of second order logic that deals with set of sets, and so it has potential applications to solve problems related to functions of sets. ¹

¹© 2020 Global Journals Set Theoretic Rajan Transform and its Properties

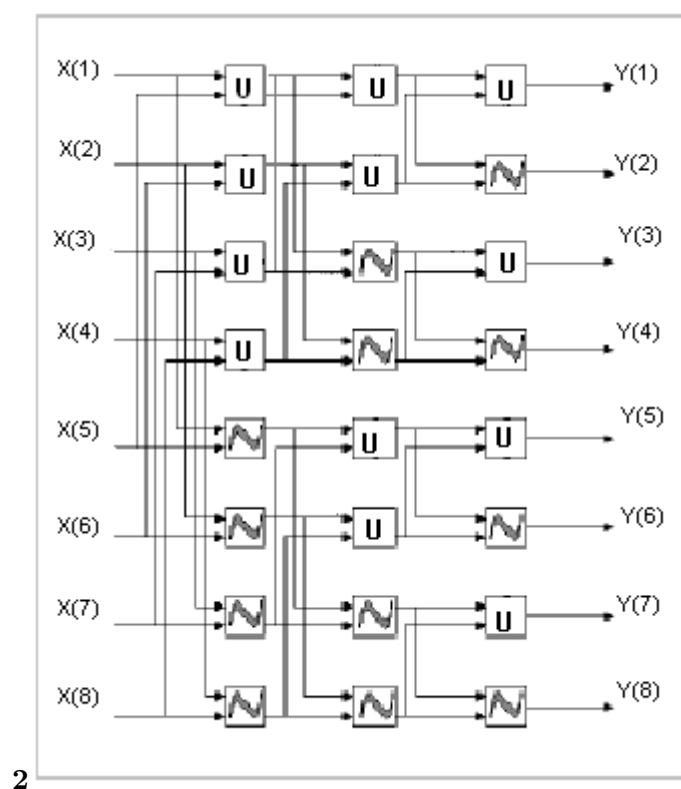


Figure 1: Fig. 2 :

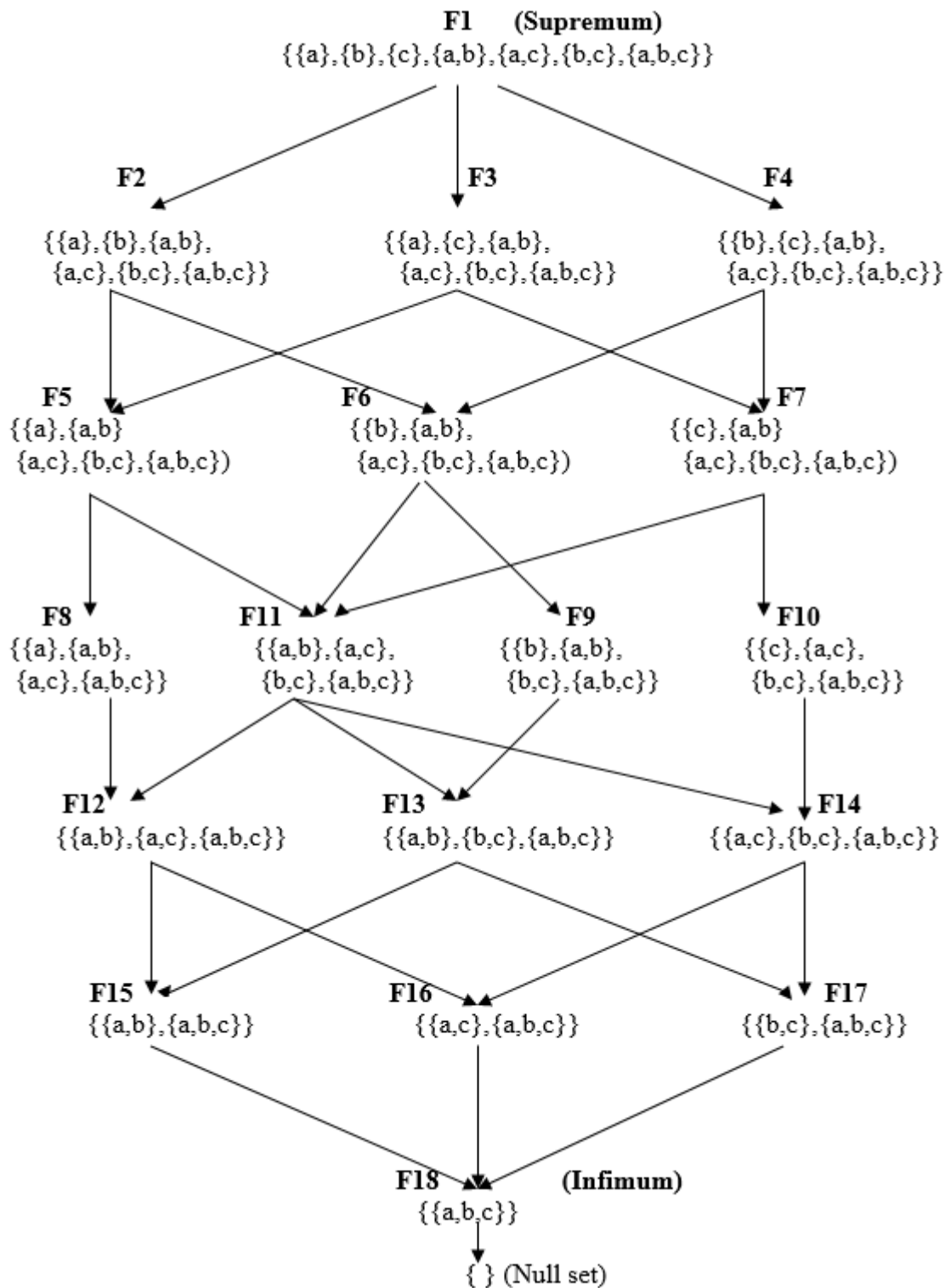


Figure 2: F1

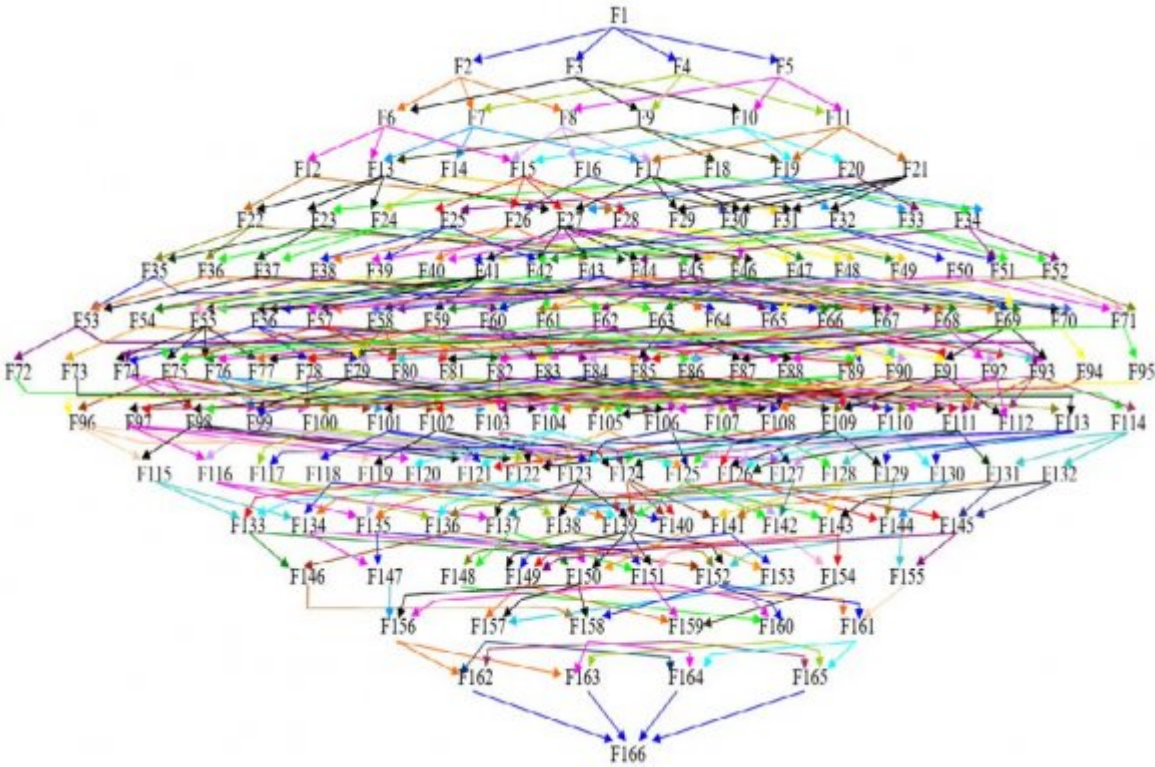


Figure 3:

2

Figure 4: Table 2 :

,c} {{a},{a63 , {a,b,c}} {{b},{a,b,c}} {{a},{a,b},{a,c},{b,c}} {{b},{c},{a,b},{a,c}} {{b},{c},{a,b},{b,c},{a,b,c}}
F18 {{a},{b},{a,c},{b,c}} {{a},{b},{a,c},{b,c}} {{a},{b},{a,c},{b,c}} {{a},{b},{a,c},{b,c}} {{a},{b},{a,c},{b,c}}
,c},

[Note: F1{{a},{b},{c},{a,b},{a,c} }, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}}
{{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} Global Journal
of Computer Science and Technology Volume XX Issue I Version IF13 {{a,b},{b,c},{a,b,c}}
{{a},{b},{c},{a,c}} {{a},{b},{c},{a,b},{a,c}, {b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}}
F15 {{a,b},{a,b,c}} {{a},{c},{a,c},{b,c}} {{a},{c},{a,b},{a,c},{b,c}} F1 {{a},{b},{c},{a,b},{a,c} },
{b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c} , {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}}
{{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} F3 {{a},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{c},{a,b},{a,c},
{b,c},{a,b,c}} {{a},{c},{a,b},{a,c}, {b,c},{a,b},{a,b},{c},{a,b},{a,c}, {b,c},{a,b,c}} F17
{{b,c},{a,b,c}} {{a},{c},{a,b},{a,c}} {{a},{c},{a,b},{a,c},{b,c}, {a,b,c}} {{b},{a,b,c}} F18 {{a,b,c}}
{{a},{a,b},{a,c},{b,c}} {{b},{c},{a,c},{b,c}} {{a},{b},{c},{a,c},{b,c}} F1 {{a},{b},{c},{a,b},{a,c},
{b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}}
{{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} F3 {{a},{c},{a,b},{a,c},{b,c},{a,b,c}} {{a},{c},{a,b},{a,c},
{b,c},{a,b,c}} {{a},{c},{a,b},{a,c},{b,c}, {a,b,c}} {{b}} ,{a,c},{b,c},{a,b,c}} {{a},{c},{a,b},{a,b,c}}
{{b},{c},{b,c},{a,b,c}} Filter chain # 28 and its STRT spectrum F1{{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}}
{{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,b,c}} F13
{{a,b},{b,c},{a,b,c}} {{a},{b},{c},{a,c}} {{a},{b},{c},{a,b},{a,c}, {b,c}} {{a},{b},{c},{a,b},{a,c},
{b,c},{a,b,c}} F15 {{a,b},{a,b,c}} {{b},{c},{a,c},{b,c}} {{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{a,b,c}} F18
{{a,b,c}} {{b},{a,b},{a,c},{b,c}} {{a},{c},{a,b},{b,c}} {{a},{b},{c},{a,b},{b,c}} F1 {{a},{b},{c},{a,b},{a,c},
{b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c}, {b,c},{a,b,c}} {{a},{b},{c},{a,b},{a,c},

Figure 5:

2

Filter No.	Filter Elements
------------	-----------------

Figure 6: Table 2 :

.1 Acknowledgement

The first author thanks the second author Professor E. G. $\{ \{a\}, \{b\}, \{c\}, \{d\}, \{a,b\}, \{a,c\}, \{a,d\}, \{b,c\}, \{b,d\}, \{c,d\}, \{a,b,c\}, \{a,b,d\}, \{a,c,d\}, \{b,c,d\}, \{a,b,c,d\} \}$ $\{ \{a\}, \{b\}, \{c\}, \{d\}, \{a,b\}, \{a,c\}, \{a,d\}, \{b,c\}, \{b,d\}, \{c,d\}, \{a,b,c\}, \{a,b,d\}, \{a,c,d\}, \{b,c,d\}, \{a,b,c,d\} \}$ F2 $\{ \{a\}, \{b\}, \{c\}, \{a,b\}, \{a,c\}, \{a,d\}, \{b,c\}, \{b,d\}, \{c,d\}, \{a,b,c\}, \{a,b,d\}, \{a,c,d\}, \{b,c,d\}, \{a,b,c,d\} \}$ $\{ \{d\} \}$ F7 $\{ \{a\}, \{c\}, \{a,b\}, \{a,c\}, \{a,d\}, \{b,c\}, \{b,d\}, \{c,d\}, \{a,b,c\}, \{a,b,d\}, \{a,c,d\}, \{b,c,d\}, \{a,b,c,d\} \}$ $\{ \{b\}, \{c\}, \{d\} \}$ F13 $\{ \{a\}, \{a,b\}, \{a,c\}, \{a,d\}, \{b,c\}, \{b,d\}, \{c,d\}, \{a,b,c\}, \{a,b,d\}, \{a,c,d\}, \{b,c,d\}, \{a,b,c,d\} \}$ $\{ \{c\}, \{d\} \}$ F22 $\{ \{a\}, \{a,b\}, \{a,c\}, \{a,d\}, \{b,c\}, \{b,d\}, \{a,b,c\}, \{a,b,d\}, \{a,c,d\}, \{b,c,d\}, \{a,b,c,d\} \}$ $\{ \{b\}, \{c\}, \{d\}, \{b,c\}, \{b,d\}, \{c,d\}, \{b,c,d\} \}$ F36 $\{ \{a\}, \{a,b\}, \{a,c\}, \{a,d\}, \{b,c\}, \{a,b,c\}, \{a,b,d\}, \{a,c,d\}, \{b,c,d\}, \{a,b,c,d\} \}$ $\{ \{b,c,d\}, \{a,b,c,d\} \}$ $\{ \{b,c,d\}, \{a,b,c,d\} \}$ F132 $\{ \{a,b\}, \{a,c\}, \{a,b,c\}, \{a,b,d\}, \{a,c,d\}, \{a,b,c,d\} \}$ $\{ \{d\}, \{a,b,c,d\} \}$ F145 $\{ \{a,b\}, \{a,b,c\}, \{a,b,d\}, \{a,c,d\}, \{a,b,c,d\} \}$ $\{ \{b\}, \{c\}, \{d\}, \{a,b,c\}, \{a,b,d\}, \{a,b,c,d\} \}$ F155 $\{ \{a,b\}, \{a,b,c\}, \{a,b,d\}, \{a,b,c,d\} \}$ $\{ \{c\}, \{d\}, \{a,b,c,d\} \}$ F161 $\{ \{a,b,c\}, \{a,b,d\}, \{a,b,c,d\} \}$ $\{ \{b\}, \{c\}, \{d\}, \{a,b\}, \{a,c\}, \{a,d\}, \{b,c\}, \{b,d\}, \{c,d\}, \{a,b,c\}, \{a,b,c,d\} \}$ $\{ \{d\}, \{a,d\}, \{b,c,d\}, \{a,b,c,d\} \}$ F166 $\{ \{a,b,c,d\} \}$ $\{ \{b\}, \{c\}, \{d\}, \{a,c\}, \{a,d\}, \{b,c\}, \{b,d\}, \{a,b,c\}, \{a,b,d\}, \{a,c,d\}, \{b,c,d\}, \{a,b,c,d\} \}$ $\{ ? \}$ $\{ \{c\}, \{d\}, \{a,d\}, \{b,d\}, \{a,b,d\}, \{a,c,d\}, \{b,c,d\}, \{a,b,c,d\} \}$