

Index

Symbols

$(\alpha e^{i\Theta}, \beta e^{i\Phi}, \gamma e^{i\Psi})$ -level hypergraph, 417
 $(\alpha e^{i\theta}, \beta e^{i\varphi})$ -level hypergraph, 119
 (α, β) -cut, 158
 (α, β, γ) -level hypergraph, 311
 (α, β, γ) -level hypergraph of \mathcal{H} , 374
 (α, β, γ) -level set, 370
 (α, β) -(weakly) cut set, 136
 (α, β) -level directed hypergraph, 112
 (α, β) -level hypergraph, 84, 161
 (α, β) -level hypergraph of q -rung orthopair fuzzy hypergraph, 240
 (α, β) -level subset, 81
 (α, β) -level vague hypergraph, 138
 (α, β) -level hypergraph of \mathcal{D} , 267
 $(\alpha, \beta, \gamma, \eta, \theta, \phi)$ -level hypergraph, 447
 $(\alpha_1 e^{i\theta}, \beta_1 e^{i\varphi})$ -level hypergraph, 283
 (η, ϕ, ψ) -level set, 384
 (λ, μ, ν) -level directed hypergraph, 400
 $(\mu e^{i\theta}, \nu e^{i\varphi})$ -level hypergraph, 288
 (μ, ν) -level hypergraph of \bar{D} , 168
2-section, 95, 379, 408
2-section graph, 263
2-section of a complex fuzzy hypergraph, 59
2-section of complex Pythagorean fuzzy hypergraph, 284
2-section of complex intuitionistic fuzzy hypergraph, 121
 $A = [\mu_A^-, \mu_A^+]$ -tempered, 132
 $B = (T_B^+, I_B^+, F_B^+, T_B^-, I_B^-, F_B^-)$ -tempered, 450
 $B = (m^+, m^-)$ -tempered bipolar fuzzy directed hypergraph, 176
 C_f -tempered complex fuzzy hypergraph, 51

E^l tempered single-valued neutrosophic hypergraph, 375
 H induced fundamental sequence, 9
 L_2 -section of a complex fuzzy hypergraph, 59
 N -tempered, 423
 T -related complex neutrosophic hypergraph, 424
 T -related crisp hypergraphs, 423
 $[\alpha, \beta]$ -level hypergraph, 129
 $[k]$ -competition hypergraph, 26
 α -level hypergraph, 40
 α -cut hypergraph, 8
 $\langle [\alpha, \beta], [\gamma, \delta] \rangle$ -cut, 144
 $\langle [\alpha, \beta], [\gamma, \delta] \rangle$ -cut, 143
 \mathcal{B} -tempered q -rung orthopair fuzzy hypergraph, 242
 \mathcal{H}_k -layer hypergraph, 62
 \mathcal{L} -coloring, 268
 $\mu e^{i\theta}$ -level hypergraph, 48
 ω -displacement, 316, 346
 τ -cut level hypergraph, 342
 bf -bipolar fuzzy directed hypergraph, 166
 d -order partition space, 346
 k -coloring of vertex set, 269
 k -uniform, 371
 k -uniform hypergraph, 3
 m -polar fuzzy r -uniform hypergraph, 191
 m -totally regular, 204
 m -fold covering, 56
 m -polar fuzzy edge set, 190
 m -polar fuzzy equivalence relation, 342
 m -polar fuzzy graph, 190, 341
 m -polar fuzzy hierarchical quotient space structure, 343

m -polar fuzzy hypergraph, 190, 342
 m -polar fuzzy quotient space, 343
 m -polar fuzzy set, 341
 m -polar fuzzy similarity relation, 342
 m -polar fuzzy vertex set, 190
 n -regular, 203
 n -uniform, 386
 q -rung orthopair fuzzy k -coloring, 269
 q -rung orthopair fuzzy digraph, 258
 q -rung orthopair fuzzy directed hypercycle, 259
 q -rung orthopair fuzzy directed hypergraph, 258
 q -rung orthopair fuzzy directed hyperpath, 259
 q -rung orthopair fuzzy graph, 237
 q -rung orthopair fuzzy hypergraph, 238
 q -rung orthopair fuzzy line graph, 261
 q -rung orthopair fuzzy relation, 237
 q -rung orthopair fuzzy set, 237
 q -rung orthopair fuzzy transversal, 244
 q -rung picture fuzzy binary relation, 312
 q -rung picture fuzzy equivalence relation, 312
 q -rung picture fuzzy graph, 310
 q -rung picture fuzzy hierarchical quotient space structure, 313
 q -rung picture fuzzy hypergraph, 310
 q -rung picture fuzzy quotient space, 312
 q -rung picture fuzzy set, 308
 q -rung picture fuzzy similarity relation, 312
 t -order partition space, 316
 \mathcal{N} -function, 37
 \mathcal{N} -covering, 44
 \mathcal{N} -graph, 37
 \mathcal{N} -hypergraph, 38
 \mathcal{N} -multigraph, 39
 \mathcal{N} -partition, 44
 \mathcal{N} -relation, 37
 \mathcal{N} -structure, 37
 m -polar fuzzy relation, 189, 341

A

Accuracy, 179, 298
 Addition, 171, 226
 Adjacent, 386, 465
 Adjacent hyperedges, 54
 Adjacent level, 8, 239, 446
 Adjacent vertices, 370, 397
 Anti rank, 3, 6, 371, 386

B

Backward bipolar fuzzy directed hyperarc, 166
 Backward bipolar fuzzy directed hypergraph, 166
 Backward q -rung orthopair fuzzy directed hypergraph, 259
 Basic elementary join, 249
 Basic sequence, 422
 Bipolar fuzzy covering, 183
 Bipolar fuzzy digraph, 159
 Bipolar fuzzy directed hyperarc, 165
 Bipolar fuzzy directed hypergraph, 165
 Bipolar fuzzy graph, 159
 Bipolar fuzzy hypergraph, 159
 Bipolar fuzzy hyperpath, 165
 Bipolar fuzzy multigraph, 160
 Bipolar fuzzy number, 179
 Bipolar fuzzy partition, 183
 Bipolar fuzzy relation, 158
 Bipolar fuzzy relation on B , 158
 Bipolar fuzzy sets, 156, 187
 Bipolar neutrosophic directed hyperarc, 464
 Bipolar neutrosophic directed hypergraph, 464
 Bipolar neutrosophic directed hyperpath, 477
 Bipolar neutrosophic graph, 445
 Bipolar neutrosophic hypergraph, 445
 Bipolar neutrosophic transversal, 453
 Bipolar single-valued neutrosophic graph, 444
 Bipolar single-valued neutrosophic relation, 444
 Bipolar single-valued neutrosophic set, 444
 Blocks, 319
 Bottom-up construction procedure, The, 323

C

Cardinality, 371, 386
 Cartesian product, 62, 110, 170, 193
 Chromatic number, 269
 Closed neighborhood, 203
 Closed neighborhood degree, 203
 Cluster, 107
 Clustering, 5
 Clustering problem, 393
 Coarse gained universe, 332, 352
 Co-authorship network, 68
 Cofuzzy graph, 6
 Complete, 206
 Complete intuitionistic fuzzy hypergraph, 93

Complex fuzzy graph, 47
 Complex fuzzy hypergraph, 48
 Complex fuzzy hyperpath, 60
 Complex fuzzy relation, 47
 Complex fuzzy set, 47
 Complex intuitionistic fuzzy graph, 118
 Complex intuitionistic fuzzy hypergraph, 119
 Complex intuitionistic fuzzy line graph, 120
 Complex intuitionistic fuzzy set, 118
 Complex intuitionistic fuzzy transversal, 122
 Complex neutrosophic graph, 415
 Complex neutrosophic hypergraph, 416
 Complex neutrosophic relation, 415
 Complex neutrosophic set, 415
 Complex neutrosophic transversal, 422
 Complex Pythagorean fuzzy graph, 281
 Complex Pythagorean fuzzy hypergraph, 281
 Complex Pythagorean fuzzy line graph, 283
 Complex Pythagorean fuzzy set, 281
 Complex Pythagorean fuzzy transversal, 284
 Complex q -rung orthopair fuzzy graph, 286
 Complex q -rung orthopair fuzzy hypergraph, 288
 Complex q -rung orthopair fuzzy relation, 286
 Complex q -rung orthopair fuzzy set, 285
 Complex q -rung orthopair fuzzy transversal, 290
 Complex q -rung orthopair fuzzy transversal core, 296
 Connected, 92, 165, 403, 478
 Connected q -rung orthopair fuzzy directed hypergraph, 260
 Connected single-valued neutrosophic hypergraph, 370
 Core hypergraphs, 267, 387, 400, 448
 Core hypergraphs of \bar{D} , 168
 Core hypergraphs or core set of q -rung orthopair fuzzy hypergraph, 242
 Core set, 40, 84, 138, 161
 Covering, 320, 348
 Co-weak isomorphism, 85, 115, 469
 Co-weak isomorphism of complex fuzzy hypergraphs, 55
 Crisp graph, 2
 Crisp hypergraph, 3
 Crisp transversal, 11
 Cut level set of q -rung orthopair fuzzy set, 240

D

Degree, 88, 386
 Degree $d_{\mathcal{H}}(v)$ of a vertex, 372
 Degree of a single-valued neutrosophic hyperedge, 371
 Degree of indeterminacy, 365
 Degree of membership, 365
 Degree of nonmembership, 365
 Depth, 445
 Depth of a bipolar fuzzy set, 158
 Destination, 397
 Destination vertex, 166, 259
 Difference, 322, 349
 Directed hyperarc, 110
 Directed hyperedge, 165, 397
 Directed hyperpath, 166
 Direct product, 195
 Dual, 145, 390
 Dual fuzzy hypergraph, 11
 Dual intuitionistic fuzzy hypergraph, 95
 Dual of a hypergraph, 3
 Dual of an \mathcal{N} -hypergraph, 42
 Dual q -rung orthopair fuzzy directed hypergraph, 263
 Dual single-valued neutrosophic directed hypergraphs, 404
 Dual single-valued neutrosophic hypergraph, 380
 Dual vague hypergraph, 140

E

Elementary, 113, 167, 387, 398, 447
 Elementary bipolar fuzzy hypergraph, 159
 Elementary bipolar fuzzy set, 159
 Elementary fuzzy hypergraph, 6
 Elementary fuzzy set, 6
 Elementary interval-valued fuzzy hypergraph, 128
 Elementary interval-valued fuzzy set, 128
 Elementary interval-valued intuitionistic fuzzy set, 147
 Elementary intuitionistic fuzzy set, 82
 Elementary \mathcal{N} -function, 38
 Elementary \mathcal{N} -hypergraph, 38
 Elementary q -rung orthopair fuzzy hypergraph, 239
 Elementary q -rung orthopair fuzzy set, 239
 Elementary single-valued neutrosophic hypergraph, 373
 Elementary single-valued neutrosophic set, 373
 Elementary vague hypergraph, 137
 External zoom-out operator, 335, 355

F

Forward bipolar fuzzy directed hypergraph, 166
 Forward bipolar fuzzy hyperarc, 166
 forward q -rung orthopair fuzzy directed hypergraph, 259
 Frog's prey, 158
 Fundamental sequence, 9, 40, 84, 112, 130, 138, 148, 161, 374, 387, 418, 448
 Fundamental sequence of \mathcal{D} , 267
 Fundamental sequence of $\mathcal{H} = (\mathcal{Q}, \eta)$, 290
 Fundamental sequence of $\mathcal{H} = (C, \xi)$, 50
 Fundamental sequence of \bar{D} , 168
 Fundamental sequence of q -rung orthopair fuzzy hypergraph, 242
 Fundamental sequence of single-valued neutrosophic directed hypergraph, 400
 Fuzzy closed neighborhood, 14
 Fuzzy closed neighborhood hypergraph, 24
 Fuzzy column hypergraph, 14
 Fuzzy competition graph, 17
 Fuzzy competition hypergraph, 18
 Fuzzy covering, 5
 Fuzzy digraph, 6
 Fuzzy double competition hypergraph, 20
 Fuzzy edge set, 5
 Fuzzy enmity hypergraph, 31
 Fuzzy graph, 5
 Fuzzy hypergraph, 6
 Fuzzy in neighborhood, 14
 Fuzzy k -competition hypergraph, 23, 26
 Fuzzy niche hypergraph, 21
 Fuzzy niche number, 22
 Fuzzy open neighborhood, 14
 Fuzzy open neighborhood hypergraph, 24
 Fuzzy out neighborhood, 14
 Fuzzy partition, 5
 Fuzzy relation, 5
 Fuzzy row hypergraph, 14
 Fuzzy set, 5, 187
 Fuzzy transversal, 12
 Fuzzy vertex set, 5

G

Generalized intuitionistic fuzzy set, 383
 Granular computing, 307
 Granule, 317
 Group decision making, 79

H

Head, 165, 259, 397, 464

Height, 37, 81, 111, 127, 136, 143, 370, 371, 384, 386, 398, 445
 Height and depth, 466
 Height of a q -rung picture fuzzy set, 310
 Height of a bipolar fuzzy set, 158
 Height of \bar{D} , 167
 Height of fuzzy hypergraph, 6
 Height of fuzzy set, 5
 Height of q -rung orthopair fuzzy directed hypergraph, 259
 Height of q -rung orthopair fuzzy hypergraph, 238
 Hesitancy degree, 79
 Homomorphism, 114, 468
 Homomorphism of complex fuzzy hypergraphs, 54
 Hyperedge, 3
 Hypernetworks, 105, 183, 409

I

Incidence matrix, 166, 397
 Incidence matrix representation, 166
 In-degree, 466
 Index, 40
 Induced fundamental sequence, 400
 Information entropy, 315, 345
 Internal zoom-out operator, 335, 355
 Intersection, 310, 349
 Intersection of two granules, 321
 Interval number, 126
 Interval-valued fuzzy class, 126
 Interval-valued fuzzy graph, 127
 Interval-valued fuzzy hypergraph, 127
 Interval-valued fuzzy relation, 126
 Interval-valued fuzzy set, 126
 Interval-valued intuitionistic fuzzy hypergraph, 144
 Interval-valued intuitionistic fuzzy set, 143
 Interval-valued intuitionistic fuzzy transversal, 152
 Intuitionistic fuzzy covering, 108
 Intuitionistic fuzzy directed hyperarc, 110
 Intuitionistic fuzzy directed hyperedge, 110
 Intuitionistic fuzzy directed hypergraph, 110
 Intuitionistic fuzzy graph, 81, 238
 Intuitionistic fuzzy hypercycle, 92
 Intuitionistic fuzzy hypergraph, 81
 Intuitionistic fuzzy hyperpath, 92
 Intuitionistic fuzzy line graph, 94
 Intuitionistic fuzzy multigraph, 82
 Intuitionistic fuzzy partition, 107
 Intuitionistic fuzzy relation, 80

Intuitionistic fuzzy sets, 79, 80, 155, 443
 Intuitionistic fuzzy transversal, 117
 Intuitionistic index, 79
 Intuitionistic single-valued neutrosophic graph, 384
 Intuitionistic single-valued neutrosophic hypergraph, 385
 Intuitionistic single-valued neutrosophic set, 383
 Intuitionistic single-valued neutrosophic transversal, 392
 Isomorphism, 85, 115, 469
 Isomorphism of complex fuzzy hypergraphs, 55

J

Join, 199

K

Knowledge space, 313, 343
 k -regular, 467

L

Lexicographic product, 200
 Linear, 261, 283, 404
 Linear complex intuitionistic fuzzy hypergraph, 120
 Linear hypergraph, 3
 Linear intuitionistic fuzzy hypergraph, 94
 Linear single-valued neutrosophic hypergraph, 371
 Line graph, 3
 Locally minimal complex neutrosophic transversal, 422
 Locally minimal complex q -rung orthopair fuzzy transversal, 297
 Locally minimal fuzzy transversal, 12
 Locally minimal interval-valued intuitionistic fuzzy transversal, 153
 Locally minimal q -rung orthopair fuzzy transversal, 244
 Lower truncation, 248

M

Maximal crisp rank preserving direct product, 66
 Maximum degree of a single-valued neutrosophic hypergraph, 372

Methods for computing fuzzy row hypergraph and fuzzy column hypergraph, The, 15
 Minimal bipolar neutrosophic transversal, 453
 Minimal complex neutrosophic transversal, 422
 Minimal complex q -rung orthopair fuzzy transversal, 291
 Minimal crisp rank preserving direct product, 64
 Minimal fuzzy transversal, 12
 Minimal interval-valued intuitionistic fuzzy transversal, 152
 Minimal intuitionistic fuzzy transversal, 117
 Minimal single-valued neutrosophic transversal, 382
 Minimal transversal, 11, 393
 Minimal transversal of \mathcal{H} , 244
 Multiplication, 174

N

Negative support, 158, 444
 Negative-valued function, 37
 Neutrosophic sets, 366
 Nodes, 136
 Non-elementary, 159
 Nonelementary intuitionistic fuzzy hypergraph, 82
 Normal, 81, 127, 158, 238, 370, 384
 Normal fuzzy set, 5

O

Object space, 317, 328, 347
 Open neighborhood, 201
 Order, 115, 205, 371, 386, 446
 Order and size, 86
 Ordered, 84, 113, 130, 138, 139, 148, 162, 168, 268, 292, 375, 388, 401, 448
 Ordered and simply ordered, 418
 Ordered complex fuzzy hypergraph, 51
 Ordered \mathcal{N} -hypergraph, 40
 Order of a q -rung orthopair fuzzy hypergraph, 238
 Order of fuzzy hypergraph, 6
 Order of q -rung orthopair fuzzy directed hypergraph, 259
 Order relation, 188
 Out-degree, 466

P

Partial, 146, 448
 Partial complex q -rung orthopair fuzzy hypergraph, 292
 Partial hypergraph, 242
 Partial hypergraph of complex fuzzy hypergraph, 50
 Partial intuitionistic fuzzy directed hypergraph, 113
 Partial intuitionistic fuzzy hypergraph, 84
 Partial intuitionistic single-valued neutrosophic hypergraph, 387
 Partial single-valued neutrosophic directed hypergraph, 401
 Partial single-valued neutrosophic hypergraph, 375
 Partition, 319, 348, 394
 Partition sequence, 315, 345
 Picture fuzzy set, 308
 Planet surface networks, 101
 Positive strength, 477
 Positive support, 158, 444
 Primitive k -coloring, 268
 Pythagorean fuzzy graph, 238

R

Radio coverage network, 105
 Rank, 3, 6, 371, 386
 Rank and anti rank of complex fuzzy hypergraph, 54
 Regular single-valued neutrosophic hypergraph, 372

S

Score, 179
 Score function, 298
 Sectionally elementary, 10, 40, 130, 138, 148, 161, 168, 374, 387, 401, 448
 Sectionally elementary complex fuzzy hypergraph, 50
 Sectionally elementary q -rung orthopair fuzzy hypergraph, 242
 Sequentially simple, 271
 Set of basic cuts, 422
 Set of core hypergraphs, 40, 138, 148
 Similarity, 313, 343
 Simple, 39, 83, 111, 129, 137, 146, 160, 167, 311, 374, 387, 399, 446, 465
 Simple and support simple, 119
 Simple and support simple complex Pythagorean fuzzy hypergraph, 282
 Simple fuzzy hypergraph, 7

Simple hypergraph, 3
 Simple q -rung orthopair fuzzy hypergraph, 239
 Simply ordered, 10, 40, 84, 130, 138, 139, 148, 162, 168, 268, 402, 448
 Simply ordered \mathcal{N} -hypergraph, 40
 Single-valued line directed graph, 406
 Single-valued neutrosophic digraph, 370
 Single-valued neutrosophic directed hypercycle, 403
 Single-valued neutrosophic directed hypergraph, 397
 Single-valued neutrosophic directed hyperpath, 403
 Single-valued neutrosophic edge set, 369
 Single-valued neutrosophic graph, 369
 Single-valued neutrosophic hypergraph, 370
 Single-valued neutrosophic line graph, 378
 Single-valued neutrosophic line graph $L(\mathcal{H})$ of \mathcal{H} , 379
 Single-valued neutrosophic relation, 369
 Single-valued neutrosophic set, 368
 Single-valued neutrosophic transversal, 382
 Single-valued neutrosophic vertex set, 369
 Size, 115, 205, 371, 386, 446
 Size of a q -rung orthopair fuzzy hypergraph, 238
 Size of q -rung orthopair fuzzy directed hypergraph, 259
 Social network, 99
 Source, 397
 Source vertex, 110, 165, 259
 Spike, 167
 Spike reduction, 270
 Strength, 9, 43, 146, 372, 388, 399, 403, 477
 Strength of q -rung orthopair fuzzy directed hyperpath, 259
 Strength of a bipolar fuzzy hyperpath, 165
 Strength of complex fuzzy hyperpath, 61
 Strength of connectedness, 165, 259, 403, 478
 Strength of intuitionistic fuzzy hyperpath, 92
 Strong, 23
 Strong arc, 478
 Strong hyperedges, 9
 Strong intuitionistic fuzzy hypergraph, 93
 Strongly support simple, 39, 83, 129, 137, 160, 374, 399, 446, 465
 Strongly support simple fuzzy hypergraph, 7
 Strongly support simple q -rung orthopair fuzzy hypergraph, 239
 Strong or effective, 478
 Strong product, 195

Structural subtraction, 175
 Subblock sequence, 316, 346
 Sub-granule, 322, 350
 Super-granule, 322, 350
 Support, 37, 81, 136, 143, 238, 370, 383, 444
 Support and height of a complex neutrosophic set, 416
 Support and height of a complex q -rung orthopair fuzzy set, 287
 Support hypergraph, 9
 Support level, 9, 84, 161
 Support of a bipolar fuzzy set, 158
 Support of a q -rung picture fuzzy set, 310
 Support of fuzzy set, 5
 Support simple, 39, 83, 111, 129, 137, 147, 160, 167, 374, 399, 446, 465
 Support simple fuzzy hypergraph, 7
 Support simple q -rung orthopair fuzzy hypergraph, 239
 Supporting edges, 167
 Symmetric, 5, 80, 158

T

Tail, 165, 259, 397, 464
 Tempered interval-valued intuitionistic fuzzy hypergraph, 150
 Tempered intuitionistic single-valued neutrosophic hypergraph, 388
 Tempered vague hypergraph, 140
 Top-down construction procedure, 323
 Transition level, 248
 Transversals of bipolar neutrosophic hypergraphs, 453
 Triangular bipolar fuzzy number, 179

U

Underlying fuzzy graph, 14
 Uniform, 3
 Uniform fuzzy hypergraph, 6
 Union, 197, 310, 349
 Union and intersection of bipolar fuzzy sets, 158
 Union of two granules, 321
 Upper truncation, 248

V

Vague graph, 136
 Vague hypergraph, 136
 Vague relation, 135
 Vague set, 135
 Vague value, 135
 Value domain, 313, 343
 Vertex symmetric and hyperedge symmetric, 3
 Vertexwise multiplication, 171

W

Weak isomorphism, 85, 115, 468
 Weak isomorphism of complex fuzzy hypergraphs, 55

Y

YinYang bipolar fuzzy sets, 155, 443

Z

Zoom-in operator, 327, 332, 351
 Zoom-out operator, 327, 334, 351, 354