

## CUMULATIVE SUBJECT INDEX<sup>1</sup>

### Volumes 36-39

#### A

- Algebraic forests
  - and inverse homomorphisms, **37**, 182
- Algebraic properties
  - operator precedence languages, **37**, 115
- Algebraic structure
  - of finite-state Markov processes, **38**, 179
- Algorithms
  - prediction, for nonrecursive sequences, **37**, 234
- Announcement
  - Int. Symp. Multivariate Analysis, 5th, **36**, 118
- Arithmetic hierarchy
  - bounded, **36**, 102
- Arithmetic residue codes
  - multiple-error-correcting, **36**, 28
- Automata
  - cellular, speeding of synchronization, **36**, 245
  - complexity of identification from given data, **37**, 302
  - decomposition, practical, **36**, 275
  - deterministic stateless pushdown, equivalence problem for, **38**, 367
  - finite
    - with cost functions, **37**, 40
    - decomposition of, **38**, 288
  - left-discrimination sequence of, **36**, 56
  - stratified tessellation, Garden-of-Eden configurations in **36**, 234
  - tree, context-dependent, **38**, 81

#### B

- Binary images
  - of extended quaternary quadratic residue codes over Galois field, **38**, 148
- Block codes
  - linear, optimal encodings for unequal error protection, **37**, 150

- Boolean proof
  - of Richardson's theorem on graph theory, **39**, 1
- Boundedness
  - local, and Shannon entropy, **36**, 292
- Bounding filter
  - simple solution to lack of exact a priori statistics, **39**, 212
- Bounds
  - tape, for subclasses of deterministic context-free languages, **37**, 321
- Branch-and-bound
  - procedure, combinatorial optimization problems, **36**, 1
- Burst-error
  - correcting codes, **39**, 303

#### C

- Cell lineage
  - system, for describing growth of filamentous organisms, **37**, 280
- Channels
  - with additive non-Gaussian noise, capacity, **37**, 34
  - degraded broadcast, trellis coding for, **39**, 119
  - Gaussian, without feedback: capacity, **37**, 70
  - multiple access, coding for, **36**, 256
  - white Gaussian, with nonlinear feedback: mutual information in, **37**, 178
- Clusters
  - in digital pictures, **39**, 19
- Codes
  - arithmetic residue, multiple-error-correcting, **36**, 28
  - burst-error correcting, **39**, 303
  - convolutional, generalized permutations in, **38**, 213

<sup>1</sup> Boldface number indicates appropriate volume; lightface number indicates pagination.

- equivalence of, proof of MacWilliams theorem on, 37, 19
  - extended quaternary quadratic residue, over Galois field: binary images of, 38, 148
  - finite prefix, combinatorial property of, 37, 267
  - linear block, optimal encoding for unequal error protection, 37, 150
  - residue, correction of multiple errors and detection of additive overflow in, 39, 46
  - over  $Z_m$ , revisited, 37, 100
  - Coding
    - for multiple-access channel, 36, 256
    - source, with side information at the decoder: rate-distortion function for, 38, 60
    - trellis, for degraded broadcast channels, 39, 119
  - Combinatorial filing systems
    - multiple valued, for multiattribute queries, 36, 119
  - Combinatorial optimization
    - problems, branch-and-bound procedure and state-space representation, 36, 1
  - Combinatorial property
    - of finite prefix codes, 37, 267
  - Combinatorial systems
    - reducing operator for, 37, 197
  - Complexity dips
    - in random infinite binary sequences, 38, 258
  - Conditional mutual information
    - for arbitrary ensembles, definition, 38, 51
  - Configurations
    - Garden-of-Eden, existence in stratified tessellation automata, 36, 234
  - Context-dependent tree automata
    - new family of tree automata, 38, 81
  - Context free
    - grammar forms, context sensitive languages and, 39, 135
    - graph grammars, theory and formal properties, 37, 207
    - languages, deterministic: subclasses, tape bounds for, 37, 321
    - matrix forms, 39, 158
  - Context sensitive
    - grammars, in elementary bounded languages, 39, 177
    - languages
      - scale of, applications to natural language, 38, 1
      - universal grammars and, 39, 135
  - Contours
    - simply connected closed, sampling theorem for, 39, 87
  - Control-limit
    - policies, optimal: for zero-memory replacement problem, 37, 90
  - Control networks
    - asynchronous, interconnecting, 38, 343
  - Convolutional codes
    - generalized permutations in, 38, 213
  - Correlations
    - multivariate symmetric, nonnegative entropy measures of, 36, 133
  - Cost function
    - finite automata with, 37, 40
  - Crosses
    - for nondeterministic off-line machines, 36, 174
- D
- Data
    - given, complexity of automaton identification from, 37, 302
  - Decision problems
    - fuzzy, formulation: with fuzzy information, 38, 135
    - two-criteria linear-quadratic-Gaussian, with one-step delay observation sharing pattern, 38, 21
  - Decision process
    - sequential, nondeterministic models, 37, 40
  - Decoder
    - source coding with side information at, 38, 60
  - Decomposition
    - of finite automata, 38, 288
    - practical, of automata, 36, 275
  - Deterministic context-free languages
    - subclasses, tape bounds for, 37, 321
  - Deterministic 0L systems
    - growth functions, 36, 85
  - Deterministic pushdown automata
    - stateless, equivalence problem for, 38, 367

- Digital pictures
  - clusters in, 39, 19
  - geodesics in, 36, 74
- Disjunctive languages
  - on free monoid, properties, 37, 334
- Dyadic logic
  - third order, undecidability of unification problem, 38, 170
  
- E
  
- Elementary bounded languages
  - context-sensitive, 39, 177
- Encoding
  - optimal, of linear block codes for unequal error protection, 37, 150
- Entropies
  - degree  $\beta$ , mixed theory of information, 39, 315
  - function and polymatroid, 39, 55
  - Shannon, local boundedness and, 36, 292
  - space, symmetric: nonnegative, 36, 133
- f*-Entropies
  - probability of error, and feature selection, 39, 227
- Equivalence
  - of codes, proof of MacWilliams theorem on, 37, 19
  - problem, for deterministic stateless pushdown automata, 38, 267
- Error
  - detection capability, burst-correcting codes, 39, 303
  - multiple, correction
    - arithmetic residue codes, 36, 28
    - in residue code, 39, 46
  - probability of, *f*-entropies and, 39, 227
  - protection, unequal: optimal encodings of linear block codes for, 37, 150
- Events
  - fuzzy, probability measures of: use in fuzzy decision problems, 38, 135
- Exponential languages
  - in elementary bounded languages, 39, 177
- Extended 0L languages
  - form interpretations, 38, 330
- Extended 0L systems
  - propagating chain-free normal forms for, 36, 309
- Extended quaternary quadratic residue codes
  - binary images of, 38, 148
- Extended TOL systems
  - of finite index, 38, 103
  
- F
  
- Feature
  - selection, *f*-entropies and, 39, 227
- Feedback
  - Gaussian channel without, capacity, 37, 70
  - nonlinear, white Gaussian channels with: mutual information in, 37, 178
- Filamentous organisms
  - cell lineage system for describing growth, 37, 280
- Filing systems
  - combinatorial multiple-valued, for multi-attribute queries, 36, 119
- Filter
  - bounding, simple solution to lack of exact a priori statistics, 39, 212
- Finite
  - automata
    - with cost functions, 37, 40
    - decomposition of, 38, 288
  - index
    - ETOL systems of, 38, 103
    - grammars, family of languages with only, 39, 14
    - restriction on families of grammars, 39, 284
  - prefix codes, combinatorial property of, 37, 267
- Finite state
  - predictors, for Gaussian sequences, 39, 35
- Forests
  - algebraic, and inverse homomorphisms, 37, 182
- Forms
  - normal, chain free: propagation for EOL systems, 36, 309
- Fourier transforms
  - multivariate, plain and covariant, 39, 73
- Function
  - cost, finite automata with, 37, 40
  - entropy, and polymatroid, 39, 55
  - growth, of DOL systems, 36, 85

- rate distortion, for source coding with side information at the decoder, 38, 60
- structure-generating, of regular sets, characterization, 36, 85
- Fuzzy
- decision problems: formulation, with fuzzy information, 38, 135
  - events: probability measures of, use in fuzzy decision problems, 38, 135
  - information, fuzzy decision problems with, 38, 135
  - logic, and probability uncertainty logics, 38, 154
  - mathematical programming, theorems derived, 38, 241
- G
- Galois field
- extended quaternary quadratic residue codes over, binary images of, 38, 148
  - polynomials from trinomials over, 37, 5
- Garden-of-Eden configurations
- existence in stratified tessellation automata, 36, 234
- Gaussian channel
- without feedback, capacity, 37, 70
  - white, with nonlinear feedback: mutual information in, 37, 178
- Gaussian sequences
- finite state predictors for, 39, 35
- Geodesics
- in digital pictures, 36, 74
- Goto
- statements, minimal: programs with, 37, 105
- Grammars
- context-sensitive, in elementary bounded languages, 39, 177
  - forms, context-free: context-sensitive languages and, 39, 135
  - families of, effect of finite index restriction on, 39, 284
  - finite-index, family of languages with only, 39, 14
  - graph, context-free, 37, 207
  - stochastic regular, inference of, 38, 310
  - universal and left universal, and context-sensitive languages, 39, 135
- Graph
- grammars, context-free, 37, 207
  - theory, Boolean proof of Richardson's theorem on, 39, 1
- Growth
- filamentous organisms, description by cell lineage system, 37, 280
  - functions, of DOL systems, 36, 85
- H
- Hierarchy
- bounded arithmetic, 36, 102
- Homomorphisms
- inverse, algebraic forests and, 37, 182
  - simplifications of, 38, 298
- I
- Images
- binary, of extended quaternary quadratic residue codes over Galois field, 38, 148
- Index
- finite
  - ETOL systems of, 38, 103
  - grammars, family of languages with only, 39, 14
  - restriction on families of grammars, 39, 284
- Inference
- minimum, complexity of: regular sets, 39, 337
  - of stochastic regular grammars, 38, 310
- Information
- conditional mutual, for arbitrary ensembles: definition, 38, 51
  - fuzzy, fuzzy decision problems with, 38, 135
  - mixed theory of, inset entropies of degree  $\beta$ , 39, 315
  - mutual, in white Gaussian channels with nonlinear feedback, 37, 178
  - useful, measures of, 39, 323
- Integrations
- successive, used in real-time least-squares estimation, 36, 42
- Interpolation theorems
- for program schemata, 36, 217

- K
- Karpovsky  
method of, comments on, 39, 243
- L
- Languages  
*m*-adic probabilistic, recursiveness of, 39, 143  
context sensitive  
scale of, applications to natural language, 38, 1  
universal grammars and, 39, 135  
deterministic  
context-free: subclasses, tape bounds for, 37, 321  
OL systems, growth functions, 36, 85  
disjunctive, on free monoid: properties, 37, 334  
elementary bounded, context-sensitive, 39, 177  
exponential, in elementary bounded languages, 39, 177  
extended OL  
form interpretations, 38, 330  
 $\epsilon$ -free: generated by a propagating EOL system, 36, 309  
family of, having only finite-index grammars, 39, 14  
1-locally linear, 37, 1  
natural, scale of context sensitive languages applied to, 38, 1  
noncontext-free rational stochastic, 39, 225  
operator precedence, algebraic properties, 37, 115  
polynomial, in elementary bounded languages, 39, 177  
stable string, of Lindenmayer systems, 37, 134  
translation, role of semantics, 36, 320  
tree, tree transducers and, 37, 241
- Law of the excluded middle  
in fuzzy and probability uncertainty logics, 38, 154
- Least squares  
estimation, using successive integrations, 36, 42
- Left-discrimination  
sequence of automaton, 36, 56
- L* forms  
uniform interpretations, 36, 157
- Lindenmayer systems  
stable string languages of, 37, 134
- Linear block codes  
optimal encodings for unequal error protection, 37, 150
- Linear languages  
1-locally, 37, 1
- Linear-quadratic-Gaussian decision problems  
two-criteria, with one-step delay observation sharing pattern, 38, 21
- Linear stochastic system  
statistical properties, 39, 92
- Logic  
design, multiple-valued: method of Karpovsky, 39, 243  
fuzzy and probability uncertainty, 38, 154
- M
- Machines  
nondeterministic off-line Turing: visits, crosses, and reversals for, 36, 174
- MacWilliams theorem  
on equivalence of codes, proof, 37, 19
- Maps  
response, over rings: split realizations of, 37, 23
- Markov processes  
finite-state, algebraic structure, 38, 179
- Matrix forms  
context-free, 39, 158
- Measures  
nonnegative entropy, of multivariate symmetric correlations, 36, 133
- Monoid  
free, disjunctive languages on, 37, 334
- Multiattribute queries  
combinatorial multiple-valued filing systems for, 36, 119
- Multiple access channel  
coding for, 36, 256
- Multivariate symmetric correlations  
nonnegative entropy measures of, 36, 133
- Mutual information  
conditional, for arbitrary ensembles: definition, 38, 51  
in white Gaussian channels with nonlinear feedback, 37, 178

## N

- Natural language
  - scale of context sensitive languages applied to, 38, 1
- Networks
  - control, asynchronous: interconnecting, 38, 343
- Noise
  - non-Gaussian, additive: capacity of channels with, 37, 34
- Non-commutative indeterminates
  - nonlinear models, 38, 264
- Nondeterministic off-line machines
  - Turing: visits, crosses, and reversals for, 36, 174
- Non-Gaussian noise
  - additive, capacity of channels with, 37, 34
- Nonlinear feedback
  - white Gaussian channels with, mutual information in, 37, 178
- Nonnegative entropy measures
  - of multivariate symmetric correlations, 36, 133
- Nonrecursive sequences
  - prediction algorithms for, 37, 234
- Normal forms
  - chain free, propagation for EOL systems, 36, 309

## O

- Observation sharing pattern
  - one-step delay, two-criteria LQG decision problems with, 38, 21
- Operator
  - reducing, for combinatorial systems, 37, 197
- Operator precedence languages
  - algebraic properties, 37, 115
- Optimization
  - combinatorial, problems: branch-and-bound procedure and state-space representation, 36, 1
- Organisms
  - filamentous, cell lineage system for describing growth, 37, 280
- Overflow
  - additive, detection in residue code, 39, 46

## P

- Parallelism principle
  - speeding of cellular automata synchronization, 36, 245
- Permutations
  - generalized, in convolutional codes, 38, 213
- Pictures
  - digital
    - clusters in, 39, 19
    - geodesics in, 36, 74
- Polymatroid
  - entropy function and, 39, 55
- Polynomial
  - irreducible, generation from trinomials over Galois field, 37, 5
  - languages, in elementary bounded languages, 39, 177
  - toggle register, properties, 39, 149
- Prediction
  - of nonrecursive sequences, 37, 234
- Predictors
  - finite state, for Gaussian sequences, 39, 35
- Prefix codes
  - finite, combinatorial property of, 37, 267
- Probabilistic language
  - $m$ -adic, recursiveness of, 39, 143
- Probability logic
  - fuzzy logic and, 38, 154
- Process
  - decision, sequential: nondeterministic models, 37, 40
- Programming
  - fuzzy mathematical, theorems derived, 38, 241
- Programs
  - with minimal goto statements, 37, 105
- Program schemata
  - interpolation theorems, 36, 217

## Q

- Queries
  - multiattribute, combinatorial filing systems for, 36, 119

## R

- Random variables
  - set of, polymatroidal dependence structure of, 39, 55

- Rate-distortion function
    - for source coding with side information at the decoder, 38, 60
  - Realizations
    - split, of response maps over rings, 37, 23
  - Real-time
    - least-squares estimation, using successive integrations, 36, 42
  - Recursiveness
    - of  $m$ -adic probabilistic language, 39, 143
  - Reducing operator
    - for combinatorial systems, 37, 197
  - Regular sets
    - complexity of minimum inference of, 39, 337
    - structure-generating functions, 36, 85
  - Regular systems
    - bilinear
      - non-commutative indeterminates for, 38, 264
      - variant of, 39, 82
  - Replacement
    - zero-memory, optimal: control-limit policies, 37, 90
  - Residue code
    - correction of multiple errors and detection of additive overflow in, 39, 46
  - Response maps
    - over rings, split realizations of, 37, 23
  - Reversals
    - for nondeterministic off-line machines, 36, 174
  - Richardson's theorem
    - on graph theory, Boolean proof, 39, 1
  - Rings
    - commutative, split realizations of response maps over, 37, 23
- S
- Sampling theorem
    - for simply connected closed contours, 39, 87
  - Schemata
    - program, interpolation theorems for, 36, 217
  - Semantic-syntax
    - directed translation, 36, 320
  - Sentences
    - skeletal structural descriptions, 39, 192
  - Sequences
    - Gaussian, finite state predictors for, 39, 35
    - left-discrimination, of automaton, 36, 56
    - nonrecursive, prediction algorithms for, 37, 234
    - random infinite binary, complexity dips in, 38, 258
  - Sequential decision process
    - nondeterministic models, 37, 40
  - Sets
    - of random variables, polymatroidal dependence structure of, 39, 55
    - regular
      - complexity of minimum inference of, 39, 337
      - structure-generating functions, 36, 85
  - Shannon entropy
    - local boundedness and, 36, 292
  - Side information
    - at decoder, source coding with, 38, 60
  - Skeletons
    - structural descriptions, 39, 192
  - Source coding
    - with side information at the decoder, rate-distortion function for, 38, 60
  - Stable string languages
    - of Lindenmayer systems, 37, 134
  - State-space
    - representation, combinatorial optimization problems, 36, 1
  - Statistical properties
    - linear stochastic system, 39, 92
  - Statistics
    - inexact, in bounding filter, 39, 212
  - Stochastic grammars
    - regular, inference of, 38, 310
  - Stochastic languages
    - noncontext-free rational, 39, 225
  - Stochastic system
    - linear, statistical properties, 39, 92
  - String languages
    - stable, of Lindenmayer systems, 37, 134
  - Structure-generating functions
    - of regular sets, characterization, 36, 85
  - Synchronization
    - cellular automata, speeding up by parallelism principle, 36, 245
  - Systems
    - regular (bilinear)
      - non-commutative indeterminates for, 38, 264
      - variant of, 39, 82

## T

- Tape
  - bounds, for subclasses of deterministic context-free languages, 37, 321
- Tessellation automata
  - stratified, Garden-of-Eden configurations in, 36, 234
- Theorems
  - interpolation, for program schemata, 36, 217
- Third order dyadic logic
  - undecidability of unification problem, 38, 170
- Toggle register
  - polynomial, properties, 39, 149
- Transducers
  - tree, and tree languages, 37, 241
- Transforms
  - Fourier, multivariate: plain and co-variant, 39, 73
- Translation
  - formal methodology
    - capabilities and limitations, 39, 272
    - semantic preserving translations, 39, 247
  - semantic-syntax directed, 36, 320
- Tree
  - automata, context-dependent, 38, 81
  - languages, tree transducers and, 37, 241
  - transducers, and tree languages, 37, 241
- Trellis coding
  - for degraded broadcast channels, 39, 119
- Trinomials
  - over Galois field, polynomials from, 37, 5

## U

- Uncertainty logic
  - fuzzy logic and, 38, 154
- Unequal error protection
  - optimal encodings of linear block codes for, 37, 150
- Unification
  - problem, third order dyadic: undecidability of, 38, 170
- Universal grammars
  - and context-sensitive languages, 39, 135

## V

- Variables
  - random, set of: polymatroidal dependence structure of, 39, 55
- Visits
  - for nondeterministic off-line machines, 36, 174

## W

- White Gaussian channels
  - with nonlinear feedback, mutual information in, 37, 178

## Z

- $Z_m$ 
  - codes over, revisited, 37, 100
- Zero-memory replacement
  - optimal, control-limit policies, 37, 90