

INDEX

- Algorithm, see Undecidability, Time iteration
- Analysis,
 - labeling process in, 19-21
 - lack of general procedure, 108-110, 213
 - of iterative networks, 106-109
 - of iterative systems, 4, 9
 - of multidimensional systems, 27-40
 - of regular bilateral systems, 16-27, 209-210
 - of regular unilateral systems, 14-16, 106, 209
 - of transient behavior, 71-80, 109, 211
 - of two-dimensional systems, 27-38, 108, 210
- Asynchronous operation,
 - of nonregular networks, 162-164, 173, 215
 - of regular networks, 161
- Atrubin, A. J., 183
- Autonomous systems, *4
 - see also specific types of systems
- Bilateral systems,
 - nonregular,
 - capabilities of, 94
 - partial separation of, *171-173
 - separation of, 167-170, 173-174, 216
 - synchronous delays in, 173
 - synthesis of, 167-175
 - two-dimensional realization of, 174-175
 - types of, 92-94, 212
 - of combinational cells, memory in, 73-74, 92-94
 - regular,
 - analysis of, 16-27, 107, 209-210
 - canonical form for, *23, 82, 167
 - capabilities of, 82-86, 212
 - coredundance in, 198-206
 - equivalence test for, 23-27
 - labeling of, 19-21
 - regular expressions for, 82-83, 212
 - separation of, 16-21, 82, 165-167
 - single-output, 83-86
 - synthesis of, 165-167, 215-216
 - relation to two-way flow systems, 72-75
 - test for regularity, 22
 - transient analysis of, 71-80
 - undecidable questions about, 75-80
- Binary counting, 130-131
- Binary representation of intercell signals, 147
- Boundary conditions, *4, 50, 159, 208
 - relation to initial states, 68
- Boundary States, 19
- Caldwell, S. H., 14
- Canonical form of regular bilateral system, *23, 82, 167
- Cell, *3, 208
 - behavior,
 - independent of intercell signals, 152
 - independent of primary input, 151, 192, 193
 - doubling, 146
- Cell matrix, 167
- Cell memory, see types of systems
- Cell state, *4, 208
- Cell transition matrix, *14, 113
- Checking network, 135-136
- Classification,
 - of primary inputs, 112, 113
 - of systems, 11, 81, 209
- Coding, effects on signal equivalence, 194
- Collapsing,
 - one-dimensional system to sequential circuit, 158-161
 - two-dimensional network to one dimension, 157
- Common input set, *33, 35
- Comparison network, 52-55
- Composite label matrix, 24
- Composite labels, 23-24
 - gross, 33-37
- Composition, *8
- Computation,
 - of nonregular networks, *86
 - of unilateral networks,

- Computation of unilateral networks
 - independent of primary inputs, 151
 - 192-193
 - restarting, 150-156
- Computation time, *140
 - of condensed networks, 161
 - of two-dimensional networks, 164, 184
 - of two-dimensional realization of bilateral network, 174-175
 - of unilateral network, 132, *140, 144, 161
 - interchange with signals and states, 145-150, 214
- Condensed networks, *159-161
- Connected cells, *177
- Coredundance, *198, 216
 - in regular bilateral systems, 198-206
 - in two-dimensional systems, 196-197
 - used to eliminate signals, 202, 206
- Correspondence problem, 41-42
- Counter circuit, 148
- Counting,
 - binary, 130-131
 - examples of, 119, 124
 - in two-dimensional systems, 179-181
 - unary, 130
- Cycles, *5, 6-7
 - in bilateral systems, 71-80
 - in unilateral systems with memory, 65-71, 132-139
 - undecidable questions about, 46-47, 70, 79-80, 211
- Decidable systems, *12, 209-210
 - bilateral, 16-27
 - multidimensional, 27-40
 - relation to system graph, 60-62, 211
 - unilateral, 14-16
- Decomposition of systems, 206-207
- Delay,
 - in condensed networks, 158-161
 - intercell, 4, 208
 - in bilateral systems, 73-74, 92-94, 173
 - in unilateral systems, 70, 161
- Distance between cells, *177
- Distinguishable labels, *23
- Distinguishable signals,
 - in multidimensional systems, *190
 - in two-dimensional systems, *187
 - in unilateral systems, *15
 - see also Coredundance
- "Don't care" conditions, 124, 129, 194
- Doubling of cells, 146
- Effective input sets, 30-36, 39
- Effective inputs, *27, 210
- Effective outputs, *27
- Equilibrium signals, 65, 142
- Equilibrium states, *5, 6-7, 208
 - determination of, in bilateral network, 17-22
 - undecidable questions about, 47, 48
- Equivalence,
 - label, *23, 209
 - network, *7, 208
 - of internal states, 187, 191, 216
 - of signals,
 - in multidimensional systems, *190, 216
 - in nonregular unilateral systems, 192-195
 - in regular unilateral systems, *15, 16
 - in two-dimensional systems, *188-195
 - limitations of, 194-195
 - of systems, *7, 208
 - bilateral, 23-27
 - multidimensional, 33-40, 62
 - nonregular, *64
 - undecidable questions about, 45-46, 60-62, 69-70, 211
 - of types of nonregular bilateral systems, 92-94, 212
- Error signal, 125
- Expansion of one-dimensional network to two dimensions, 156
- False outputs, *141-145, 214
- Four-way flow systems,
 - capabilities of, 96-99, 212
 - separation of, 99-101
 - stable form of, 184
 - undecidability in, 47-48
- Graph, system, *11, 37, 210
 - relation to decidable systems, 60-62, 211
- Gross composite label sets, 33-37
- Gross label sets, *30, 210
- Gross state sets, *30
- Hartmanis, J., 206
- Indices, *41, 49
- Initial state,
 - of nonregular system, 63-64
 - of unilateral systems, 65-68, 70-71
- Input sets,
 - common, *33, 35
 - effective, 30-36, 39
- Inputs,
 - effective, *27, 210
 - primary, see Primary inputs
- Interlocking operation, 162
- Internal states, see States, internal

- Iteration, see Space iteration, Time iteration
- Iterative networks, 1, 3
- Iterative sequential networks, 158
- Iterative systems, *4, 109-110, 208
 - relation to sequential circuits, 157
 - see also Systems, and particular types of systems
- Kernel, *39
- Kleene, S. C., 81
- Label matrices, *20, 21, 107, 167, 209
 - composite, 24
 - in synthesis, 166-167
- Label sets, *19, 209
 - gross, *30, 210
- Labeling, 19-21, 108
- Labels, *19
 - composite, 23-24
 - distinguishable, *23
 - equivalent, *23, 209
 - gross composite, 33-37
- McCluskey, E. J., 14
- Matrices, see Cell matrix, Label matrices, State matrices
- Memory,
 - in bilateral systems of combinational cells, 73-74, 92-94
 - see also specific types of systems
- Moore, E. F., 14
- Multidimensional systems,
 - analysis of, 27-40
 - effective inputs in, *27
 - equivalence of, 33-40, 62
 - equivalent signals in, *190, 216
 - gross label sets in, *30, 210
 - lack of stability tests for, 80
 - reduced form of, 190
 - regularity of, 29-33, 37-40, 62
 - synthesis of, 175-179
 - undecidable questions about, 60-62, 80
- Multiplication, in regular systems, 171
- Network equivalence, *7, 208
- Network stability, *5
- Network state, *5, 208
 - see also Equilibrium state
- Networks,
 - analysis of, 106, 109
 - composition of, *8
 - condensed, 159-161
 - regular, *5
 - single-output, *4
 - see also Single-output systems
 - transient behavior of, 63, 195
 - see also Systems
- Nodes, ordering of, *37
- Nonregular systems, *5
 - capabilities of, 87-89, 94, 179
 - computation of, *86
 - computation time of, *140
 - see also Computation Time
 - equivalence of, *64
 - initial states of, 63-67, 70-71
 - see also specific types of systems
- Null output, 141, 143
- Null signal, 147
- Number generator, 132-135, 139
- One-dimensional systems, see Unilateral, Bilateral systems
- Order,
 - of nodes, *37
 - of subsystems, *38
- Output circuit, 167-170
- Output cycle, *5
- Output matrix, *22, 167
- Outputs,
 - effective, *27
 - false, 141-145, 214
 - null, 141, 143
 - of coredundant states, 201-202
 - primary, see Primary outputs
- Parallel combination, *8
- Partial separation,
 - of nonregular bilateral systems, *171-173
 - of two-dimensional systems, 178-179
- Post's problem, 41-42, 210
 - relation to two-dimensional systems, 42-43, 49-55, 210-211
- Premature outputs, 141-145
- Primary inputs, *3, 208
 - classes of, 112-113
 - examples, 117, 125
 - remembered within cell, 151, 192-193
- Primary outputs, *3, 208
 - as matrix entries, 193-194
 - generation of, 167-170
 - see also Computation
- in bilateral networks, determination of, 107
- undecidable questions about, 43-45, 68-69, 75, 211
- Prime detector, 132-138, 145
- Provisional stability, *141
- Quadrants, in two-dimensional networks, 175-178
- Reduced form,
 - of multidimensional system, 190
 - of regular bilateral system, *23, 82, 167
 - of two-dimensional system, *189, 194-196
 - of unilateral system, 15

- Regular expression, 81-83, 212
- Regular networks and systems, *5
 - see also specific types of systems
- Regularity,
 - related to stability, 12-14
 - undecidable questions about, 46-47, 60-62, 211
- Regularity test,
 - for bilateral systems, 22
 - for multidimensional systems, 29-33, 37-40
- Restarting, 150-156, 164, 215
- Reversibility,
 - of two-dimensional systems, 104, 212
 - of unilateral systems, 85
- Scanning,
 - one-dimensional networks, *122
 - see also Time iteration
 - two-dimensional networks, 179-182
- Separation,
 - of four-way flow systems, 99-101
 - of nonregular bilateral systems, 167-170, 173-174, 216
 - of regular bilateral systems, 16-21, 82, 165-167
 - of three-way flow systems, 103
 - of two-dimensional systems, 108, 175-178
 - partial, see Partial separation
 - undecidable questions about, 100, 104
- Sequence generator, 44-45, 57-60
- Sequential circuits,
 - as output circuits, 169-170
 - in space-iteration synthesis, 118, 119
 - iterative, 157-158
 - see also Nonregular systems, Unilateral systems
- Signal flow, classification of, 11, 81, 209
- Signals,
 - composite, *8
 - distinguishable, see Distinguishable signals
 - eliminated by coredundance, 202, 206
 - equilibrium, 65, 142
 - equivalence of, see Equivalence
 - error, 125
 - null, 147
 - related to internal states, 157
 - states and computation time, 145-150, 214
- Signal sequences, see Space iteration
- Simulation networks, 76-79
- Single-output systems, *4
 - regular one-dimensional, 83-86
 - two-dimensional, 96-99, 101-103
- Skewed systems, *44, 55-57
- Space iteration,
 - in one-dimensional systems, *114, 116-129, 214
 - in two-dimensional systems, 183-184
 - sequential circuits in, 118, 119
- Space-time diagram, *67, 123, 70-73
- Space-time transformation, 156-161, 184, 215
- Stability, *5, 208
 - affected by coredundance, 203-206
 - provisional, *141
 - related to regularity, 12-14
 - undecidable questions about, 46-47, 70, 75-80, 211
 - wide sense, *90
- Stability test for unilateral systems
 - with memory, 65-67
- Stable forms, 184
- Stable systems, see specific types of systems
- State cycles, *5
- State matrices, *17-20, 209
- State sets, gross, *30
- States,
 - boundary, 19
 - cell, *4, 208
 - equilibrium, see Equilibrium states
 - initial, see Initial states
 - internal,
 - equivalence of, 187, 191, 216
 - relation to signals, 157
 - signals and computation time, 145-150, 214
 - network, *5, 208
- Subsystems, *38, 39
- Synchronization,
 - of bilateral systems, 92-94, 173
 - of two-dimensional systems, 181
 - of unilateral systems, 64, 161
- Synthesis,
 - of iterative systems, 4, 111, 217
 - of unstable systems, 132-139¹
 - see also specific types of systems
- System graph, see Graph, system
- Systems, *4, 109-110, 208
 - analysis of, 4, 9
 - autonomous, *4
 - classification of, 11, 81, 209
 - decidable, see Decidable systems
 - equivalence of, see Equivalence
 - nonregular, see Nonregular systems
 - regular, *5
 - see specific types of systems
 - single-output, see Single-output systems
 - skewed, *44, 55-57
 - synthesis of, 4

Systems, transient behavior of, 63, 195
see also specific types of systems

T leads, *50

Testing networks, 77-79

Three-way flow systems,
 capabilities of, 96-99, 101-103, 212
 separation of, 103
 stable form of, 184
 undecidability in, 46-47, 103-104, 211

Time, see Computation time, Space-time diagram, Space-time transformation

Time iteration,
 in one-dimensional systems, *114-116, 119, 121, 214
 in two-dimensional systems, 179-183

Transfer circuit, 137-138

Transformation, space-time, 156-161
 184, 215

Transient analysis, 71-80, 109, 211

Transient behavior, 63, 195

Transition diagram, 51-52

Transition matrix, *14, 113

Translation network, 49-52

Two-dimensional realization,
 of bilateral systems, 174-175
 of unilateral systems, 156, 163-164

Two-dimensional systems,
 analysis of, 27-38, 108, 210
 asynchronous operation with, 163-164, 174-175

computation time of, 164, 184
 coredundance in, 196-197
 counting in, 179-181
 equivalent signals in, 187, *188-195
 nonregular, 179-184
 partial separation of, 178-179
 reduced form of, *189, 194-196
 relation to Post's problem, 42-43, 49-55, 210-211

reversibility of, 104, 212

scanning in, 179-182

separation of, 108, 175-178

space iteration in, 183-184

stable forms of, 184

synchronization of, 181

time iteration in, 179-183

transformed to one-dimensional systems, 156-161

undecidability in, 43-48, 99-100, 103-104, 211

see also Two-way flow, Three-way flow, Four-way flow

Two-way flow systems,
 relation to bilateral systems, 72-75
 relation to unilateral systems with memory, 67-68, 70-71
 undecidable questions about, 43-46, 211

Unary counting, 130

Undecidability, meaning of, 42, 49, 109

Undecidable questions,

about bilateral systems, 75, 80

about capabilities of systems, 89-90, 99, 103

about equilibrium states, 47, 48

about four-way flow systems, 47-48, 99, 100

about multidimensional systems, 60-62, 80

about primary outputs, 43-45, 68-69, 75, 211

about regularity, 46-47, 60-62, 211

about separability, 100, 104

about stability, 46-47, 70, 75-80, 211

about system equivalence, 45-46, 60-62, 69-70, 211

about three-way flow systems, 46-47, 103-104, 211

about two-way flow systems, 43-46, 211

about unilateral systems, 68-70, 89-90

Post's problem, 41-42, 210

Undecidable systems, *12, 41-62, 210-211

Unilateral systems,

regular,

analysis of, 14-16, 106, 209

asynchronous operation of, 161

capabilities of, 82-86, 212

equivalent signals in, 15-16

in time-iteration synthesis, 119

reduced form of, 15

regular expressions for, 81-82

reversibility of, 85

single output, 83-86

synthesis of, 112-114

transition matrix for, *14, 15, 113

with cell memory,

asynchronous operation of, 162-164, 215

capabilities of, 87-89, 94, 212

computation of, *86

computation time, *140-144, 161

condensed to sequential circuit, 158-161

cycles in, 65-71, 132-139

equivalent signals in, 192-195

initial states of, 65-71

intercell delays in, 70

relation to two-way flow systems, 67-68, 70-71

restarting, 150-156, 164, 215

space-time diagram for, *67, 123

stability test, 65-67

synthesis of, 114-139, 213-215

two-dimensional expansion, 156, 163-164

undecidable questions, 68-70, 89-90

Unsolved problems, 217

Unstable systems,

capabilities of, 90-91

computation time of, 140, 144

false outputs in, 144, 145

prime detector, 132-138, 145

unilateral, 132-139

Wide sense stability, *90

see also Unstable systems