

# Index

## A

- A posteriori* approach (optimization), 65
- A priori* approach (optimization), 65
- ACO. *See* Ant colony optimization, 71
- Adaptive neuro-fuzzy inference system, 62
- AI/FEM hybrid models, 5
- AISI 1045 steel, 80
- ALE formulation. *See* Arbitrary Lagrangian-Eulerian formulation, 30
- ANFIS. *See* Adaptive neuro-fuzzy inference system, 62
- ANFIS architecture, 62
- ANFIS training, 64
- Ant colony optimization, 71
- Arbitrary Lagrangian-Eulerian formulation, 30
- ART. *See* Adaptive resonance theory, 51
- ART-1, 51
- ART-1 topology, 53
- Artificial intelligence, 39
- Artificial neural networks. *See* Neural networks, 3, 40, 61

## B

- Biological neuron, 40
- Brozzo's damage criterion, 34

## C

- Case of study, 79
- Chip formation, 80
- Clustering algorithm, 51
- Cockcroft-Latham damage criterion, 34

- Cohesive friction model, 33
- Coulomb's simple friction model, 31
- Crossover, 68

## D

- Design of experiments, 79
- Differential equation set, 13

## E

- Elastic strain component, 21
- Elastic-linear work-hardening behavior, 22
- Elastic-nonlinear work-hardening behavior, 22
- Elastic-perfectly plastic behavior, 22
- Elastic-plastic matrix, 29
- Empirical models, 2
- Error back-propagation algorithm, 44
- ES. *See* Evolution strategies, 66
- Eulerian formulation
  - boundary conditions, 26
  - constitutive relation, 25
  - definition, 24
  - finite element formulation, 29, 30
  - initial conditions, 27
  - kinematic relation, 25
  - motion equation, 26
  - rigid-plastic behavior, 27
- Evolution strategies, 66
- Evolutionary computation, 66
- Evolutionary multi-objective optimization, 68

**E** (*cont.*)

Exact RBFN, 48  
 Experimental stress-strain curve, 20

**F**

FEM. *See* Finite element method, 13  
 FEM model settings, 80  
 FEM/AI hybrid models, 4  
 Finite element, 14  
 Finite element method, 2, 13  
 Fourier's law, 30  
 Freudenthal's damage criterion, 34  
 Fuzzy FEM, 8  
 Fuzzy inference rules, 59  
 Fuzzy inference system, 60  
 Fuzzy logic, 58  
 Fuzzy operations, 59

**G**

GA. *See* Genetic algorithms, 66, 67  
 Galerkin method, 15  
 Generalized midpoint rule, 30  
 Genetic algorithms, 66

**H**

Hamilton's principle, 17  
 Heat generation, 31  
 Hebbian rule, 50  
 Hillerborg's fracture energy, 36  
 Hollomon's stress-strain law, 22  
 Hooke's law, 21  
 Hopfield networks, 49  
 Hybrid FEM/AI optimization, 7

**I**

Initial yielding criterion, 24  
 ISO P20 tungsten carbide, 80

**J**

J-C law. *See* Johnson-Cook's model, 23  
 Johnson-Cook's shear failure model, 35  
 Johnson-Cook's model, 23

**K**

Kohonen networks. *See*  
 Self-organizing maps, 54

**L**

Lagrangian formulation  
 boundary conditions, 29  
 constitutive relation, 28  
 definition, 27  
 finite element formulation, 29, 30  
 initial conditions, 29  
 kinematic relation, 27  
 motion equation, 29  
 Linear elastostatics, 16  
 Ludwik's stress-strain law, 22  
 Mamdani fuzzy inference system, 60  
 Material hardening function, 22, 26  
 MATLAB, 87  
 McCulloch and Pitts neuron model, 40  
 Membership function, 58  
 Modified Coulomb's friction model, 32  
 Multilayer perceptron, 43  
 Multi-layer perceptron, 87  
 Multi-objective optimization, 64  
 Multiple regression, 85  
 Mutation, 68

**N**

Neural networks  
 activation function, 41  
 definition, 40  
 feed-forward, 42  
 ggregation function, 41  
 layer, 41  
 learning procedures, 43  
 mathematical indetermination, 57  
 misusing, 56  
 over-fitting, 58  
 recurrent, 42  
 statistic tests, 58  
 synapse, 40  
 topology, 41  
 Neuro-fuzzy system, 61  
 Newton's law of cooling, 31  
 Nodal force vector, 19  
 Nodes, 18  
 Numerical integration, 30

**O**

Optimization, 3, 64, 89  
 Oxley's thermo-viscoplastic model, 23

**P**

Paretian dominance, 66  
 Pareto front, 66, 90

Pareto optimal, 66  
Particle swarm optimization, 74  
Perceptron rule for Hopfield networks, 50  
Phenomenological models, 2  
Plastic strain component, 21  
Plasticity, 20  
Power law of thermo-viscoplasticity, 23  
Progressive approach (optimization), 65  
PSO. *See* Particle swarm optimization, 71, 74

**R**

Radial basis function networks, 46  
    learning, 47  
Rate-independent plasticity, 20  
RBFN. *See* Radial basis function network, 41,  
    42, 46

**S**

SA. *See* Simulated annealing, 3, 71, 74  
Selection, 67  
Self-organizing maps, 54  
Shape functions, 19  
Simulated annealing, 74  
Single-objective optimization, 64  
Soft computing, 39  
Specific distortion damage criterion, 34  
Stiffness matrix, 19, 29  
Strain rate-independent plastic models, 22  
Strain-displacement matrix, 19  
Stress index parameter damage criterion, 34  
Sugeno fuzzy inference system, 60  
Swarm intelligence, 71  
Swift's stress-strain law, 22

**T**

Thermal properties, 80  
Thermo-viscoplastic models, 23  
Tresca's yielding criterion, 24

**U**

Usui and Shirakashi's friction model, 32  
Usui's wear model, 83

**V**

Variational method, 15  
Viscoplastic models, 23  
Viscoplasticity, 20  
Voce's stress-strain law, 22  
Von Mises' yielding criterion, 24

**W**

Weak form, 14  
Weighted residual method, 15

**Y**

Young's modulus, 21

**Z**

Zerilli and Armstrong constitutive  
    model, 23