Bibliography

E. Aarts and J. Lenstra. *Local Search in Combinatorial Optimization*. Princeton Universality Press, 2003.

H. Abbas and M. Fahmy. Neural Networks for Maximum Likelihood Clustering. *Signal Processing*, vol. 36, no.1, pp. 111-126, 1994.

B. Al-kazemi and C. Mohan. Multi-phase Discrete Particle Swarm Optimization. In *the Third International Workshop on Frontiers in Evolutionary Algorithms*, Atlantic City, New Jersey, USA, 2000.

N. Alldrin, A. Smith and D. Turnbull. Clustering with EM and K-means, unpublished Manuscript, 2003, http://louis.ucsd.edu/~nalldrin/research/cse253_wi03.pdf (visited 15 Nov 2003).

K. Al-Sultan. A Tabu Search Approach to Clustering Problems. *Pattern Recognition*, vol. 28, pp. 1443-1451, 1995.

M. Amadasun and R. King. Low-level Segmentation of Multispectral Images via Agglomerative Clustering of Uniform Neighborhoods. *Pattern Recognition*, vol. 21, no. 3, pp. 261-268, 1988.

M. Anderberg. *Cluster Analysis for Applications*. Academic Press, New York, USA, 1973.

P. Angeline. Evolutionary Optimization versus Particle Swarm Optimization: Philosophy and Performance Difference. In *Proceedings of the Seventh Annual Conference on Evolutionary Programming*, pp. 601-610, 1998.

P. Angeline. Using Selection to Improve Particle Swarm Optimization. In *International Conference on Evolutionary Computation*, Piscataway, New Jersey, USA, pp. 84-89, IEEE Service Center, 1998.

J. Antoniades, D. Haas, P. Palmadesso, M. Baumback and L. J. Rickard. Use of Filter Vectors in Hyperspectral Data Analysis. In *Proceedings of SPIE*, vol. 2553, pp 128-139, 1995.

G. Babu and M. Murty. A Near-Optimal Initial Seed Value Selection in K-means Algorithm Using a Genetic Algorithm. *Pattern Recognition Letters*, vol. 14, no. 10, pp. 763-769, 1993.

F. Bach and M. Jordan. Learning Spectral Clustering. *Neural Information Processing Systems 16 (NIPS 2003)*, 2003.

T. Bäck. Self-Adaptation in Genetic Algorithms. In *Proceedings of the First European Conference on Artificial Life*, pp. 227-235, MIT Press, 1992.

T. Bäck, F. Hoffmeister and H. Schwefel. A Survey of Evolution Strategies. In *Proceedings of the Fourth International Conference on Genetic Algorithms and their Applications*, pp. 2-9, 1991.

S. Baek, B. Jeon, D. Lee and K. Sung. Fast Clustering Algorithm for Vector Quantization. *Electronics Letters*, vol. 34, no. 2, pp. 151-152, 1998.

R. Balasubramanian and J. Allebach. A New Approach to Platte Selection for Color Images. *Image Technology*, vol. 17, pp. 284-290, 1990.

G. Ball and D. Hall. A Clustering Technique for Summarizing Multivariate Data. *Behavioral Science*, vol. 12, pp. 153-155, 1967.

A. Bateson and B. Curtiss. A Method for Manual Endmember Selection and Spectral Unmixing. *Remote Sensing of Enviornment*, vol. 55, pp 229-243, 1996.

J. Bezdek. A Convergence Theorem for the Fuzzy ISODATA Clustering Algorithms. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 2, pp. 1-8, 1980.

J. Bezdek. *Pattern Recognition with Fuzzy Objective Function Algorithms*. Plenum Press, 1981.

H. Bischof, A. Leonardis and A. Selb. MDL Principle for Robust Vector Quantization. *Pattern Analysis and Applications*, vol. 2, pp. 59-72, 1999.

C. Bishop. *Neural Networks for Pattern Recognition*. Clarendon Press, Oxford, 1995.

N. Boujemaa. On Competitive Unsupervised Clustering. In *the International Conference on Pattern Recognition (ICPR'00)*, vol. 1, pp. 1631-1634, 2000.

E. Bonabeau, M. Dorigo and T. Theraulaz. *From Natural to Artificial Swarm Intelligence*. Oxford University Press, New York, USA, 1999.

M. Bramlette. Initialisation, Mutation and Selection Method in Genetic Algorithms for Function Optimization. In *Proceedings of the Fourth International Conference in Genetic Algorithms*, pp. 100-107, Morgan Kaufmann, 1991.

J. Braquelaire and L. Brun. Comparison and Optimization of Methods of Color Image Quantization. *IEEE Transactions on Image Processing*, vol. 6 no. 7, pp. 1048-1052, 1997.

C. Carpineto and G. Romano. A Lattice Conceptual Clustering System and Its Application to Browsing Retrieval. *Machine Learning*, vol. 24, no. 2, pp. 95-122, 1996.

M. Celenk. A Color Clustering Technique for Image Segmentation. *Computer Vision, Graphics and Image Processing*, vol. 52, pp. 145-170, 1990.

M. Chang, I. Sezan and M. Tekalp. Adaptive Bayesian Segmentation of Color Images. *Journal of Electronic Imaging*, vol. 3, no. 4, pp. 404-414, 1994.

C. Chen, J. Luo and K. Parker. Image Segmentation via Adaptive K-means Clustering and Knowledge-Based Morphological Operations with Biomedical Applications. *IEEE Transactions on Image Processing*, vol. 7, no. 12, pp. 1673-1683, 1998.

H. Cheng, X. Jaing, Y. Sun and J. Wang. Color Image Segmentation: Advances & Prospects. *Pattern Recognition*, vol.34, pp. 2259-2281, 2001.

S. Cheng and C. Yang. A Fast and Novel Technique for Color Quantization using Reduction of Color Space Dimensionality. *Pattern Recognition Letters*, vol. 22, pp. 845-856, 2001.

J. Chinneck. Practical Optimization: a Gentle Introduction, 2000. http://www.sce.carleton.ca/faculty/chinneck/po.html (visited 1 July 2004).

S. Chu and J. Roddick. A Clustering Algorithm Using Tabu Search Approach with Simulated Annealing for Vector Quantization. *Chinese Journal of Electronics*, vol. 12**,** no. 3, pp. 349-353, 2003.

F. Chung. *Spectral Graph Theory*. Society Press, 1997.

M. Clerc. The Swarm and the Queen: Towards a Deterministic and Adaptive Particle Swarm Optimization. In *Proceedings of the Congress on Evolutionary Computation*, Washington DC, USA, vol. 3, pp. 1951-1957, IEEE Press, 1999.

M. Clerc and J. Kennedy. The Particle Swarm: Explosion, Stability and Convergence in a Multi-Dimensional Complex Space. *IEEE Transactions on Evolutionary Computation*, vol. 6, pp. 58-73, 2001.

G. Coath and S. Halgamuge. A Comparison of Constraint-handling Methods for the Application of Particle Swarm Optimization to Constrained Nonlinear Optimization

Problems. In *Proceedings of IEEE Congress on Evolutionary Computation 2003 (CEC 2003)*, Canbella, Australia. pp. 2419-2425, 2003.

C.A. Coello Coello. *An Empirical Study of Evolutionary Techniques for Multiobjective Optimization in Engineering Design, PhD Thesis*. Tulane University, 1996.

C. Coello Coello and M. Lechuga. MOPSO: A Proposal for Multiple Objective Particle Swarm Optimization. In *Congress on Evolutionary Computation*, Piscataway, New Jersey, USA, vol. 2, pp. 1051-1056, IEEE Service Center, 2002.

G. Coleman and H. Andrews. Image Segmentation by Clustering. In *Proceedings of IEEE*, vol. 67, pp. 773-785, 1979.

D. Comaniciu and P. Meer. Robust Analysis of Feature Spaces: Color Image Segmentation. In *Proceedings of IEEE Conference on Computer Vision and Pattern Recognition*, pp. 750-755, 1997.

D. Comaniciu and P. Meer. Mean Shift: A Robust Approach Toward Feature Space Analysis. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 24, no. 5, pp. 603-619, 2002.

E. Davies. *Machine Vision: Theory, Algorithms, Practicalities*. Academic Press, 2nd Edition, 1997.

D. Davies and D. Bouldin. A Cluster Separation Measure. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 1, no. 2, 1979.

A. Dekker. Kohonen Neural Networks for Optimal Colour Quantization. *Network: Computation in Neural Systems*, vol. 5, pp. 351-367, 1994.

M. Delgado, A. Skarmeta and H. Barberá. A Tabu Search Approach to the Fuzzy Clustering Problem. In *the Sixth IEEE International Conference on Fuzzy Systems*, Barcelona, 1997.

J. Devore. *Probability and Statistics for Engineering and the Sciences, fourth edition*. Duxbury Press, 1995.

L. Diaz and T. Milligan. *Antenna Engineering Using Physical Optics: Practical CAD Techniques and Software (Artech House Antenna and Propagation Library*), Artech House Publishers, 1996.

M. Dorigo. *Optimization, Learning and Natural Algorithms (in Italian), PhD thesis*. Dipartimento di Elettronica, Politecnico di Milano, Italy, 1992.

M. Dorigo and G. Di Caro. *The Ant Colony Optimization Meta-Heuristic*. *New Methods in Optimization*, D. Corne, M. Dorigo and F. Glover, Eds., McGraw-Hill, 1999.

M. Dorigo, V. Maniezzo and A. Colorni. Positive Feedback as a Search Strategy. Technical Report, Report no. 91-016, Dipartimento di Elettronica, Politecnico di Milano, Italy, 1991.

J. C. Dunn. Well Separated Clusters and Optimal Fuzzy Partitions. *Journal of Cybernetics*, vol. 4, pp. 95-104, 1974.

R. Eberhart, P. Simpson and R. Dobbins. *Computational Intelligence PC Tools*. Morgan Kaufmann, 1996.

R. Eberhart and Y. Shi. Comparison between Genetic Algorithms and Particle Swarm Optimization. In *Proceedings of the Seventh Annual Conference on Evolutionary Programming*, pp. 611-619. Springer-Verlag, 1998.

R. Eberhart and Y. Shi. Evolving Artificial Neural Networks. In *Proceedings of the International Conference on Neural Networks and Brain*, Beijing, China, PL5-PL13, 1998.

R. Eberhart and Y. Shi. Comparing Inertia Weights and Constriction Factors in Particle Swarm Optimization. In *Proceedings of the Congress on Evolutionary Computing*, San Diego, USA, pp. 84-89, 2000.

A. El-Gallad, M. El-Hawary and A. Sallam. Swarming of Intelligent Particles for Solving the Nonlinear Constrained Optimization Problem. *Engineering Intelligent Systems for Electrical Engineering and Communications*, vol. 9, no. 3, pp. 155-163, 2001.

A. Engelbrecht. *Computational Intelligence: An Introduction*. John Wiley and Sons, 2002.

S. Esquivel and C. Coello Coello. On the use of Particle Swarm Optimization with Multimodal Functions. In *Proceedings of IEEE Congress on Evolutionary Computation*, pp 1130-1136, 2003.

B. Everitt. *Cluster Analysis*. Heinemann Books, London, 1974.

J. Fieldsend and S. Singh. A Multi-objective Algorithm based upon Particle Swarm Optimization, an Efficient Data Structure and Turbulence. In *The 2002 UK Workshop on Computational Intelligence*, UK, pp. 34-44, 2002.

E. Fiume and M. Quellette. On Distributed, Probabilistic Algorithms for Computer Graphics. *Graphics Interface '89*, pp. 211-218, 1989.

R. Fletcher. *Practical Methods of Optimization, second edition*. John Wiely & Sons, 2000.

C. Floudas and P. Pardalos. *Recent Advances in Global Optimization*. Princeton Universality Press, 1992.

L. Fogel. *Evolutionary Programming in Perspective: The Top-down View. Computational Intelligence: Imitating Life*, J.M. Zurada, R. Marks II and C. Robinson, Eds., Piscataway, New Jersey, USA, IEEE Press, 1994.

E. Forgy. Cluster Analysis of Multivariate Data: Efficiency versus Interpretability of Classification. *Biometrics*, vol. 21, pp. 768-769, 1965.

B. Freisleben and A. Schrader. An Evolutionary Approach to Color Image Quantization. In *Proceedings of IEEE International Conference on Evolutionary Computation*, pp. 459-464, 1997.

H. Frigui and R. Krishnapuram. Clustering by Competitive Agglomeration. *Pattern Recognition Letters*, vol. 30, no. 7, pp. 1109-1119, 1997.

H. Frigui and R. Krishnapuram. A Robust Competitive Clustering Algorithm with Applications in Computer Vision. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 21, no.5, pp. 450-465, 1999.

P. Frnti, J. Kivijrvi and O. Nevalainen. Tabu Search Algorithm for Codebook Generation in Vector Quantization. *Pattern Recognition*, vol. 31, no. 8, pp. 1139-1148, 1998.

C. Fuh, S. Cho and K. Essig. Hierarchical Color Image Region Segmentation for Content-Based Image Retreival Systems. *IEEE Transactions on Image Processing*, vol. 9, no. 1, pp. 156-162, 2000.

Y. Fukuyama and H. Yoshida. A Particle Swarm Optimization for Reactive Power and Voltage Control in Electric Power Systems. In *Proceedings of the IEEE Congress on Evolutionary Computation*, Seoul, S. Korea, pp. 87-93, 2001.

K. Gabarro. Tabu Search Algorithm, http://www.lsi.upc.es/~mallba/public/library/firstProposal-BA/node11.html (visited 18 August 2004).

Z. Gaing. Particle Swarm Optimization to Solving the Economic Dispatch Considering the Generator Constraints. *IEEE Transactions on Power Systems*, vol. 18, no. 3, pp. 1187-1195, 2003.

I. Gath and A. Geva. Unsupervised Optimal Fuzzy Clustering. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 11, no. 7, pp. 773-781, 1989.

M. Gervautz and W. Purgathofer. *A Simple Method for Color Quantization: Octree Quantization*. Graphics Gems, Academic Press, N.Y., 1990.

F. Glover. Tabu Search – Part I. *ORSA Journal on Computing*, vol. 1, no. 3, pp. 190-206, 1989.

F. Glover. Tabu Search – Part II. *ORSA Journal on Computing*, vol. 2, no. 1, pp. 4-32, 1990.

D. Goldberg. *Genetic Algorithms in search, optimization and machine learning*. Addison-Wesley, 1989.

R. Gonzalez and R. Woods. *Digital Image Processing*. Addison-Wesley, 1992.

P. Gray, W. Hart, L. Painton, C. Phillips, M. Trahan and John Wagner. A Survey of Global Optimization Methods, Sandia National Laboratories, 1997, http:// www.cs.sandia.gov/opt/survey (visited 2 July 2004).

M. Halkidi, Y. Batistakis and M. Vazirgiannis. On Clustering Validation Techniques. *Intelligent Information Systems Journal*, Kluwer Pulishers, vol. 17, no. 2-3, pp.107-145, 2001.

M. Halkidi and M. Vazirgiannis. Clustering Validity Assessment: Finding the Optimal Partitioning of a data set. In *Proceedings of ICDM Conference*, CA, USA, 2001.

M. Halkidi and M. Vazirgiannis. Clustering Validity Assessment using Multi representative. In *Proceedings of the Hellenic Conference on Artificial Intelligence, SETN*, Thessaloniki, Greece, 2002.

G. Hamerly. Learning Structure and Concepts in Data using Data Clustering, *PhD Thesis*. University of California, San Diego, 2003.

G. Hamerly and C. Elkan. Alternatives to the K-means Algorithm that Find Better Clusterings. In *Proceedings of the ACM Conference on Information and Knowledge Management (CIKM-2002)*, pp. 600-607, 2002.

G. Hamerly and C. Elkan. Learning the K in K-means. In *The Seventh Annual Conference on Neural Information Processing Systems*, 2003.

P. Heckbert. Color Image Quantization for Frame Buffer Display. *ACM Computer Graphics*, vol. 16, no. 3, pp. 297-307, 1982.

N. Higashi and H. Iba. Particle Swarm Optimization with Gaussian Mutation. In *Proceedings of the IEEE Swarm Intelligence Symposium 2003 (SIS 2003)*, Indianapolis, Indiana, USA. pp. 72-79, 2003.

A. Hlavka and M. A. Spanner. Unmixing AVHRR Imagery to Access Clearcuts and Forest Regrowth on Oregon. *IEEE Transactions on Geoscience and Remote Sensing*, vol. 33, pp 788-795, 1995.

J. Holland. Outline for a Logical Theory of Adaptive Systems. *Journal of the ACM*, vol. 3, pp. 297-314, 1962.

J. Holland. *Adaptation in Natural and Artificial Systems*. University of Michigan Press, Michigan, USA, 1975.

F. Hoppner, F. Klawonn, R. Kruse and T. Runkler. *Fuzzy Cluster Analysis, Methods for Classification, Data Analysis and Image Recognition*. John Wiley & Sons Ltd, 1999.

R. Horst, P. Pardalos and N. Thoai. *Introduction to Global Optimization*, second edition. Kluwer Academic Publishers, 2000.

X. Hu. Particle Swarm Optimization: Bibliography, 2004. http://www.swarmintelligence.org/bibliography.php (visited 8 February 2005).

X. Hu and R. Eberhart. Adaptive Particle Swarm Optimization: Detection and Response to Dynamic Systems. In *Proceedings of congress on Evolutionary Computation*, Hawaii, USA, pp. 1666-1670, 2002.

X. Hu and R. Eberhart. Multiobjective Optimization using Dynamic Neighborhood Particle Swarm Optimization. In *Proceedings of congress on Evolutionary Computation*, Hawaii, USA, pp. 1677-1681, 2002.

X. Hu and R. Eberhart. Solving Constrained Nonlinear Optimization Problems with Particle Swarm Optimization. In *the Sixth World Multiconference on Systemics, Cybernetics and Informatics (SCI 2002)*, Orlando, USA, 2002.

K. Huang. A Synergistic Automatic Clustering Technique (Syneract) for Multispectral Image Analysis. *Photogrammetric Engineering and Remote Sensing*, vol. 1, no.1, pp. 33-40, 2002.

A. Ismail and A. Engelbrecht. Global Optimization Algorithms for Training Product Unit Neural Networks. In *IEEE International Conference on Neural Networks,* Como, Italy,2000.

A. Jain and R. Dubes. *Algorithms for Clustering Data*. Prentice Hall, New Jersey, USA, 1988.

A. Jain, R. Duin and J. Mao. Statistical Pattern Recognition: A Review. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 22, no.1, pp. 4-37, 2000.

R. Jain, R. Kasturi and B. Schunck. *Machine Vision*. McGraw-Hill, Inc., New York, USA, 1995.

A. Jain, M. Murty and P. Flynn. Data Clustering: A Review. *ACM Computing Surveys*, vol. 31, no. 3, pp. 264-323,1999.

C. Janikow and Z. Michalewicz. An Experimental Comparison of Binary and Floating Point Representations in Genetic Algorithm. In *Proceedings of the Fourth International Conference in Genetic Algorithms*, pp. 31-36, Morgan Kaufmann, 1991.

A. Jensen and S. Kristensen. Basic PSO versus Multi Swarm PSO. Topics of Evolutionary Computation, EVALife, Department of Computer Science, University of Aarhus, Denmark, 2002.

D. Judd, P. Mckinley and A. Jain. Large-scale Parallel Data Clustering. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 20, no. 8, pp. 871-876, 1998.

R. Kass and L. Wasserman. A Reference Bayesian Test for Nested Hypotheses and its Relationship to the Schwarz Criterion. *Journal of the American Statistical Association*, vol. 90, no. 431, pp. 928-934, 1995.

T. Kaukoranta, P. Fränti and O. Nevalainen. A New Iterative Algorithm for VQ Codebook Generation. *International Conference on Image Processing*, pp. 589-593, 1998.

J. Kennedy. Small Worlds and Mega-Minds: Effects of Neighborhood Topology on Particle Swarm Performance. In *Proceedings of the Congress on Evolutionary Computation*, pp. 1931-1938, 1999.

J. Kennedy and R. Eberhart. Particle Swarm Optimization. In *Proceedings of IEEE International Conference on Neural Networks*, Perth, Australia, vol. 4, pp. 1942-1948, 1995.

J. Kennedy and R. Eberhart. A Discrete Binary Version of the Particle Swarm Algorithm. In *Proceedings of the Conference on Systems, Man, and Cybernetics*, pp. 4104-4109, 1997.

J. Kennedy and R. Eberhart. *Swarm Intelligence*. Morgan Kaufmann, 2001.

J. Kennedy and R. Medes. Population Structures and Particle Swarm Performance. In *Proceedings of the IEEE Congress on Evolutionary Computation*, Hawaii, USA, 2002.

J. Kennedy and W. Spears. Matching Algorithms to Problems: An Experimental Test of the Particle Swarm and Some Genetic Algorithms on the Multimodal Problem Generator. In *IEEE International Conference on Evolutionary Computation*, Achorage, Alaska, USA, 1998.

R. Klein and R. Dubes. Experiments in Projection and Clustering by Simulated Annealing. *Pattern Recognition*, vol. 22, pp. 213-220, 1989.

T. Kohonen. *Self-Organizing Maps*. Springer Series in Information Sciences, 30, Springer-Verlag, NewYork, USA, 1995.

B. Korte and J. Vygen. *Combinatorial Optimization: Theory and Algorithms*, *second edition*. Springer-Verlag, Berlin, 2002.

C. Kotropoulos, E. Augé and I. Pitas. *Two-layer Learning Vector Quantizer for Color Image Quantization*. *Signal Processing IV: Theories and Applications*, J. Vandewalle, R. Boite, M. Moonen, A. Oosterlinck, Eds., pp. 1177-1180, 1992.

J. Koza. *Genetic Programming: On the Programming of Computers by means of Natural Selection*. MIT Press, Cambridge, Massachusetts, 1992.

T. Krink, and M. Løvbjerg. The LifeCycle model: Combining Particle Swarm Optimisation, Genetic Algorithms and HillClimbers. In *Proceedings of Parallel Problem Solving from Nature VII*, pp. 621-630, 2002.

T. Krink, J. Vesterstrøm, J. Riget. Particle Swarm Optimization with Partial Particle Extension. In *Proceedings of the Fourth Congress on Evolutionary Computation*, 2002.

Krishnapuram and Keller. A Possibilistic Approach to Clustering. *IEEE Transactions on Fuzzy Systems*, vol. 1, no. 2, pp. 98-110, 1993.

Krishnapuram and Keller. The Possibilistic C-Means algorithm: Insights and Recommendations. *IEEE Transactions on Fuzzy Systems*, vol. 4, no. 3, pp. 385-393, 1996.

L. Kuncheva and J. Bezdek. Nearest Prototype Classification: Clustering, Genetic Algorithms, or Random Search?. *IEEE Transactions on Systems, Man, and Cybernetics-Part C: Applications and Reviews*, vol. 28, no. 1, pp. 160-164, 1998.

S. Kwok and A. Constantinides. A Fast Recursive Shortest Spanning Tree for Image Segmentation and Edge Detection. *IEEE Transactions on Image Processing*, vol. 6, no. 2, pp. 328-332, 1997.

C. Lee and E. Antonsson. Dynamic Partitional Clustering Using Evolution Strategies. In *The Third Asia-Pacific Conference on Simulated Evolution and Learning*, 2000.

A. Leon-Garcia. *Probability and Random Processes for Electrical Engineering*, *second edition*. Addison Wesley, 1994.

Y. Leung, J. Zhang and Z. Xu. Clustering by Space-Space Filtering. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 22, no.12, pp. 1396-1410, 2000.

A. Liew, S. Leung and W. Lau. Fuzzy Image Clustering Incorporating Spatial Continuity. In *IEE Proceedings Vision, Image and Signal Processing*, vol. 147, no. 2, 2000.

T. Lillesand and R. Kiefer. *Remote Sensing and Image Interpretation*, John Wiley & Sons Publishing, New York, USA, 1994.

A. Lorette, X. Descombes and J. Zerubia. Fully Unsupervised Fuzzy Clustering with Entropy Criterion. In *International Conference on Pattern Recognition (ICPR'00)*, vol. 3, pp. 3998-4001, 2000.

M. Løvberg. *Improving Particle Swarm Optimization by Hybridization of Stochastic Search Heuristics and Self Organized Critically*, *Master's Thesis*. Department of Computer Science, University of Aarhus, Denmark, 2002.

M. Løvberg, T. Rasmussen and T. Krink. Hybrid Particle Swarm Optimiser with Breeding and Subpopulation. In *Proceedings of the Third Genetic and Evolutionary Computation Conference*, vol. 1, pp. 469-476, 2001.

M. Løvberg and T. Krink. Extending Particle Swarm Optimizers with Self-Organized Criticality. In *Proceedings of the Fourth Congress on Evolutionary Computation*, vol. 2, pp. 1588-1593, 2002.

S. Lu and K. Fu. A Sentence-to-Sentence Clustering Procedure for Pattern Analysis. *IEEE Transaction on Systems, Man and Cybernetics*, vol. 8, pp. 381-389, 1978.

L. Lucchese and S. Mitra. Color Image Segmentation: A State-of-the-Art Survey. In *Proceedings of the Indian National Science Academy (INSA-A)*, New Delhi, India, vol. 67, no. 2, pp. 207-221, 2001.

J. MacQueen. Some Methods for Classification and Analysis of Multivariate Observations. In *Proceedings Fifth Berkeley Symposium on Mathematics, Statistics and Probability*, vol. 1, pp. 281-297, 1967.

F. Maselli. Multiclass Spectral Decomposition of Remotely Sensed Scenes by Selective Pixel Unmixing. *IEEE Transactions on Geoscience and Remote Sensing*, vol. 36, no. 5, pp. 1809-1819, 1998.

U. Maulik and S. Bandyopadhyay. Genetic Algorithm-Based Clustering Technique. *Pattern Recognition*, vol. 33, pp. 1455-1465, 2000.

G. McLachlan and T. Krishnan. *The EM algorithm and Extensions*. John Wiley & Sons, Inc., 1997.

K. Mehrotra, C. Mohan and Rakka. *Elements of Artificial Neural Networks*. MIT Press, 1997.

Z. Michalewicz. *Genetic Algorithms + Data Structures = Evolution Programs*, third edition. Springer-Verlag, Berlin, 1996.

Z. Michalewicz and D. Fogel. *How to Solve It: Modern Heuristics*. Springer-Verlag, Berlin, 2000.

C. Mohan and B. Al-Kazemi. Discrete Particle Swarm Optimization. In *Proceedings Workshop on Particle Swarm Optimization*, Purdue School of Engineering and Technology, USA, 2001.

F. Murtagh, A. Raftery and J. Starck. Bayesian Inference for Color Image Quantization via Model-Based Clustering Trees. Technical Report no. 402. Department of Statistics, University of Washington, USA, 2001.

A. Ng, M. Jordan and Y. Weiss. On Spectral Clustering: Analysis and an Algorithm. In *Proceedings of Neural Information Processing Systems (NIPS 2001)*, 2001.

J. Oliver and D. Hand. Introduction to Minimum Encoding Inference. Technical Report no. 94/205. Department of Computer Science, Monash University, Australia, 1994.

E. Ozcan and C. Mohan. Analysis of a Simple Particle Swarm Optimization System. *Intelligent Engineering Systems Through Artificial Neural Networks*, vol. 8, pp. 253-258, 1998.

N. Pal and J. Biswas. Cluster Validation using Graph Theoretic Concepts. *Pattern Recognition*, vol. 30, no. 6, 1997.

A. Pandya and R. Macy. *Pattern Recognition with Neural Networks in C++*. CRC Press, 1996.

T. Pappas. An Adaptive Clustering Algorithm for Image Segmentation. *IEEE Transactions on Signal Processing*, vol. 40, no, 4, pp. 901-914, 1992.

P. Pardalos, A. Migdalas and R. Burkard. *Combinatorial and Global Optimization*. World Scientific Publishing Company, 2002.

L. Parra, C. Spence, P. Sajda, A. Ziehe and K. Müller. Unmixing Hyperspectral Data. In *Advances in Neural Information Processing Systems 12*, MIT Press, pp. 942-948, 2000.

K. Parsopoulos and M. Vrahatis. *Particle Swarm Optimization Method for Constrained Optimization Problems*. *Intelligent Technologies - Theory and Applications: New Trends in Intelligent Technologies*, P. Sincak, J. Vascak, V. Kvasnicka and J. Pospichal, Eds., IOS Press, 2002.

E. Peer, F. Van den Bergh and A. Engelbrecht. Using Neighborhoods with the Guaranteed Convergence PSO. In *Swarm Intelligence Symposium*, Piscataway, New Jersey, USA, pp. 235-242, IEEE Service Center, 2003.

D. Pelleg and A. Moore. X-means: Extending K-means with Efficient Estimation of the Number of Clusters. In *Proceedings of the 17th International Conference on Machine Learning*, pp. 727-734, Morgan Kaufmann, San Francisco, CA, 2000.

J. Puzicha, T. Hofmann and J. M. Buhmann. Histogram Clustering for Unsupervised Image Segmentation. In *IEEE Proceedings of the Computer Vision and Pattern Recognition*, vol. 2, pp. 602-608, 2000.

V. Raghavan and K. Birchand. A Clustering Strategy Based on a Formalism of the Reproductive Process in a Natural System. In *Proceedings of the Second International Conference on Information Storage and Retrieval*, pp. 10-22, 1979.

R. Rardin. *Optimization in Operations Research*. Prentice Hall, New Jersey, USA, 1998.

A. Ratnaweera, S. Halgamuge and H. Watson. Particle Swarm Optimization with Self-adaptive Acceleration Coefficients. In *Proceedings of the 1st International Conference on Fuzzy Systems and Knowledge Discovery 2002 (FSKD 2002)*, pp. 264-268, 2003.

R. Rendner and H. Walker. Mixture Densities, Maximum Likelihood and the EM Algorithm. *SIAM Review*, vol. 26, no. 2, 1984.

R. Reynolds, B. Peng and J. Brewster. Cultural swarms II: Virtual algorithm emergence. In *Proceedings of IEEE Congress on Evolutionary Computation 2003 (CEC 2003)*, Canbella, Australia, pp. 1972-1979, 2003.

J. Riget and J. Vesterstrøm. A Diversity-Guided Particle Swarm Optimizer – The ARPSO. EVALife Technical Report no. 2002-2, 2002.

Rissanen. Modeling by Shortest Data Description. *Automatica,* vol. 14, pp. 465-471, 1978.

J. Robinson, S. Sinton and Y. Rahmat-Samii. Particle Swarm, Genetic Algorithm, and their Hybrids: Optimization of a Profiled Corrugated Horn Antenna. In *IEEE International Symposium on Antennas & Propagation*. San Antonio, Texas, USA, 2002.

C. Rosenberger and K. Chehdi. Unsupervised Clustering Method with Optimal Estimation of the Number of Clusters: Application to Image Segmentation. In *The International Conference on Pattern Recognition (ICPR'00)*, vol. 1, pp. 1656-1659, 2000.

X. Rui, C. Chang and T. Srikanthan. On the initialization and Training Methods for Kohonen Self-Organizing Feature Maps in Color Image Quantization. In *Proceedings of the First IEEE International Workshop on Electronic Design, Test and Applications*, 2002.

E. Saber, A. Tekalp and G. Bozdagi. Fusion of Color and Edge Information for Improved Segmentation and Edge Linking. In *Proceedings of IEEE International Conference on Acoustics, Speech, and Signal Processing*, vol. 4, pp. 2176-2179, 1996.

J. Saghri, A. Tescher, F. Jaradi and M. Omran. A Viable End-Member Selection Scheme for Spectral Unmixing of Multispectral Satellite Imagery Data. *Journal of Imaging Science and Technology*, vol. 44, no. 3, pp. 196-203, 2000.

J. Saghri, A. Tescher and M. Omran. Class-Prioritized Compression of Multispectral Imagery Data. *Journal of Electronic Imaging*, vol. 11, no. 2, pp. 246-256, 2002.

A. Salman. Linkage *Crossover Operator for Genetic Algorithms, PhD Dissertation*. School of Syracuse University, USA, 1999.

P. Scheunders. A Comparison of Clustering Algorithms Applied to Color Image Quantization. *Pattern Recognition Letters*, vol. 18, no. 11-13, pp. 1379-1384, 1997.

P. Scheunders. A Genetic C-means Clustering Algorithm Applied to Image Quantization. *Pattern Recognition*, vol. 30, no. 6, 1997.

P. Scheunders and S. De Backer. Joint Quantization and Error Diffusion of Color Images using Competitive Learning. In *International Conference on Image Processing*, vol. 1, pp. 811, 1997.

L. Schoofs and B. Naudts. Swarm Intelligence on the Binary Constraint Satisfaction Problem. In *Proceedings of the IEEE Congress on Evolutionary Computation (CEC 2002)*, Honolulu, Hawaii USA, 2002

J. J. Settle and N. A. Drake. Linear Mixing and Estimation of Ground Cover Proportions. *International Journal in Remote Sensing*, vol. 14, no. 6, pp 1159-1177, 1993.

S. Shafer and T. Kanade. Color Vision. *Encyclopedia of Artificial Intelligence*, pp. 124-131, Wiley, 1987.

Y. Shi and R. Eberhart. A Modified Particle Swarm Optimizer. In *Proceedings of the IEEE International Conference on Evolutionary Computation*, Piscataway, New Jersey, pp. 69-73, 1998.

Y. Shi and R. Eberhart. Parameter Selection in Particle Swarm Optimization. *Evolutionary Programming VII: Proceedings of EP 98*, pp. 591-600, 1998.

Y. Shi and R. Eberhart. Fuzzy Adaptive Particle Swarm Optimization. In *Proceedings Congress on Evolutionary Computation*, Seoul, S. Korea, 2001.

J. Shi and J. Malik. Normalized Cuts and Image Segmentation. In *Proceedings of IEEE International Conference on computer Vision and Pattern Recognition*, pp. 731-737, 1997.

P. Sneath and R. Sokal. *Numerical Taxonomy*. Freeman, London, UK, 1973.

J. Spall. *Introduction to Stochastic Search and Optimization*, first edition. Wiley-Interscience, 2003.

R. Storn and K. Price. Differential Evolution – A Simple and Efficient Heuristic for Global Optimization over Continuous Spaces. *Global Optimization*, vol. 11, pp. 341-359, 1997.

M. Su. Cluster Analysis: Chapter two Lecture notes, 2002, http://selab.csie.ncu.edu.tw/~muchun/course/cluster/CHAPTER%202.pdf (visited 15 August 2004).

P. Suganthan. Particle Swarm Optimizer with Neighborhood Optimizer. In *Proceedings of the Congress on Evolutionary Computation*, pp. 1958-1962, 1999.

S. Theodoridis and K. Koutroubas. *Pattern Recognition*. Academic Press, 1999.

J. Tou. DYNOC – A Dynamic Optimal Cluster-seeking Technique. *International Journal of Computer and Information Sciences*, vol. 8, no. 6, pp. 541-547, 1979.

J. Tou and R. Gonzalez. *Pattern Recognition Principles*. Addison-Wesley, Massachusetts, USA, 1974.

I. Trelea. The Particle Swarm Optimization Algorithm: Convergence Analysis and Parameter Selection. *Information Processing Letters*, vol. 85, no. 6, pp. 317-325, 2003.

M. Trivedi and J. Bezdek. Low-level Segmentation of Aerial Images with Fuzzy Clustering. *IEEE Transactions on Systems, Man and Cybernetics*, vol. 16, no. 4, pp. 589-598, 1986.

D. Tsou and C. MacNish. Adaptive Particle Swarm Optimisation for High-dimensional Highly Convex Search Spaces. In *Proceedings of IEEE Congress on Evolutionary Computation 2003 (CEC 2003)*, Canbella, Australia. pp. 783-789, 2003.

R.H. Turi. *Clustering-Based Colour Image Segmentation, PhD Thesis*. Monash University, Australia, 2001.

T. Uchiyama and M. Arbib. Color Image Segmentation using Competitive Learning. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 16, no. 12, pp. 1197-1206, 1994.

F. Van den Bergh. *An Analysis of Particle Swarm Optimizers, PhD Thesis*. Department of Computer Science, University of Pretoria, South Africa, 2002.

F. Van den Bergh and A. Engelbrecht. Cooperative Learning in Neural Networks using Particle Swarm Optimizers. *South African Computer Journal,* vol. 26, pp. 84-90, 2000.

F. Van den Bergh and A.P. Engelbrecht. Effects of Swarm Size on Cooperative Particle Swarm Optimizers. In *Proceedings of the Genetic and Evolutionary Computation Conference*, San Francisco, USA, pp. 892-899, 2001.

F. Van den Bergh and A.P. Engelbrecht. A New Locally Convergent Particle Swarm Optimizer. *In Proceedings of the IEEE Conference on Systems, Man, and Cybernetics*, Hammamet, Tunisia, 2002.

D. Van der Merwe and A. Engelbrecht. Data Clustering using Particle Swarm Optimization. In *IEEE Congress on Evolutionary Computation*. Canberra, Australia, pp. 215-220, 2003

P. Van Laarhoven and E. Aarts. *Simulated Annealing: Theory and Applications*. Kluwer Academic Publishers, 1987.

C. Veenman, M. Reinders and E. Backer. A Maximum Variance Cluster Algorithm. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 24, no. 9, pp. 1273-1280, 2002.

C. Veenman, M. Reinders and E. Backer. A Cellular Coevolutionary Algorithm for Image Segmentation. *IEEE Transactions on Image Processing*, vol. 12, no. 3, pp. 304-316, 2003.

K. Veeramachaneni, T. Peram, C. Mohan and L. Osadciw. Optimization Using Particle Swarm with Near Neighbor Interactions. *Lecture Notes Computer Science,* vol. 2723, Springer Verlag, 2003.

L. Velho, J. Gomes and M. Sobreiro. Color Image Quantization by Pairwise Clustering. In *Proceedings of the Tenth Brazilian Symposium on Computer Graphics and Image Processing*, pp. 203-207, 1997.

G. Venter and J. Sobieszczanski-Sobieski. Particle Swarm Optimization. In *the 43rd AIAA/ASME/ASCE/AHA/ASC Structures, Structural Dynamics and Materials Conference*, Denver, Colorado, USA, 2002.

C. Wallace. An Improved Program for Classification. Technical Report no. 47. Department of Computer Science, Monash University, Australia, 1984.

C. Wallace and D. Boulton. An Information Measure for Classification. *The Computer Journal*, vol. 11, pp. 185-194, 1968.

C. Wallace and D. Dowe. Intrinsic Classification by MML – the snob program. In *Proceedings Seventh Australian Joint Conference on Artificial Intelligence, UNE*, Armidale, NSW, Australia, pp. 37-44, 1994.

S. Wan, P. Prusinkiewicz and S. Wong. Variance-based Color Image Quantization for Frame Buffer Display. Color Research and Application, vol. 15, no. 1, pp. 52-58, 1990.

A. Watt. *Three-Dimensional Computer Graphics*. Addison-Wesley, 1989.

H. Weiss. Genetic Algorithms and Optimum Robot Design, Institute of Robotics and Mechatronics, 2003, http://www.robotic.dlr.de/Holger.Weiss/garep/node3.html (visited 6 July 2004).

D. Whitley and S. Rana. Search, Binary Representations, and Counting Optima. In *Proceeding of a Workshop on Evolutionary Algorithms*, Sponsored by the Institute for Mathematics and its Applications, 1998.

J. Wu, H. Yan and A. Chalmers. Color Image Segmentation Using Fuzzy Clustering and Supervised Learning. *Journal of Electronic Imaging*, vol. 3, no. 4, pp. 397-403, 1994.

X. Wu and K. Zhang. A Better Tree-Structured Vector Quantizer. In *Proceedings IEEE Data Compression Conference*, pp. 392-401, 1991.

Z. Xiang. Color Image Quantization by Minimizing the Maximum Inter-cluster Distance. *ACM Transactions on Graphics*, vol. 16, no. 3, pp. 260-276, 1997.

Z. Xiang and G. Joy. Color Image Quantization by Agglomerative Clustering. *IEEE Computer Graphics and Applications*, vol. 14, no. 3, pp. 44-48, 1994.

X. Xie, W. Zhang and Z. Yang. A Dissipative Particle Swarm Optimization. In *IEEE Congress on Evolutionary Computation*, Honolulu, Hawaii, USA, 2002.

K. Yasuda, A. Ide and N. Iwasaki. Adaptive Particle Swarm Optimization. In *Proceedings of IEEE International Conference on Systems, Man and Cybernetics*, pp. 1554-1559, 2003.

H. Yoshida, K. Kawata, Y. Fukuyama and Y. Nakanishi. A Particle Swarm Optimization for Reactive Power and Voltage Control Considering Voltage Stability. In *Proceedings of the International Conference on Intelligent System Application to Power Systems*, Rio de Janeiro, Brazil, pp. 117–121, 1999.

B. Zhang. Generalized K-Harmonic Means - Boosting in Unsupervised Learning. Technical Report HPL-2000-137. Hewlett-Packard Labs, 2000.

B. Zhang, M. Hsu and U. Dayal. K-Harmonic Means - A Data Clustering Algorithm. Technical Report HPL-1999-124. Hewlett-Packard Labs, 1999.

W. Zhang, Y. Liu and M. Clerc. An Adaptive PSO Algorithm for Reactive Power Optimization. In *Advances in Power System Control Operation and Management*, Hongkong. 2003.

W. Zhang and X. Xie. DEPSO: Hybrid Particle Swarm with Differential Evolution Operator. In *IEEE International Conference on Systems, Man and Cybernetics*, Washington DC, USA, pp. 3816-3821, 2003.

Y. Zhang, M. Brady and S. Smith. Segmentation of Brain MR Images Through a Hidden Markov Random Field Model and the Expectation-Maximization Algorithm. *IEEE Transactions on Medical Imaging*, vol. 20, no. 1, pp. 45-57, 2001.

Y. Zheng, L. Ma, L. Zhang and J. Qian. Robust PID Controller Design using Particle Swarm Optimizer. In *Proceedings of IEEE International Symposium on Intelligence Control*, pp. 974-979, 2003.

Appendix A

Definition of Terms and Symbols

This appendix lists the terms and symbols frequently used in this thesis.

pattern is a single object or data point used by the clustering algorithm.

cluster is a set of similar patterns, and patterns from different clusters are not similar.

N_c is the maximum number of clusters.

N_d is the dimension of the data set.

N_p is the number of patterns to be clustered. If the data set is an image (or a set of images) N_p denotes the number of image pixels.

$\Re$ is the set of all real numbers

$\boldsymbol{Z}$ denotes the dataset being clustered (i.e. the set of patterns).

$\boldsymbol{z}_p$ denotes the coordinates of pattern (or pixel) p.

$\boldsymbol{C}_k$ denotes the k^{th} cluster.

$\boldsymbol{m}_k$ denotes the centroid of $\boldsymbol{C}_k$.

K denotes the number of clusters.

$\boldsymbol{x}_i$ is the current position of particle i.

$\boldsymbol{v}_i$ is the current velocity of particle i.

$\boldsymbol{y}_i$ is the personal best position of particle i.

$\hat{\boldsymbol{y}}_i$ is the neighborhood best position of particle i.

$\hat{\boldsymbol{y}}$ is the position of the global best particle.

f denotes the function being optimized.

t denotes time or time steps.

Appendix B

Derived Publications

This appendix provides a list of publications that have been published, or are currently being reviewed, that were derived from the work introduced in this thesis.

Journal Publications:

1. M. Omran, A. Engelbrecht and A. Salman. Particle Swarm Optimization Method for Image Clustering. To appear in the in the *International Journal of Pattern Recognition and Artificial Intelligence*.
2. A. Salman, M. Omran and A. Engelbrecht. SIGT: Synthetic Image Generation Tool for Clustering Algorithms. To appear in the *ICGST International Journal on Graphics, Vision and Image Processing (GVIP)*, vol. V2, pp. 33-44, January, 2005.
3. M. Omran, A. Salman and A. Engelbrecht. Dynamic Clustering using Particle Swarm Optimization with Application in Image Segmentation. *Pattern Recognition*, submitted 2004.
4. M. Omran, A. Engelbrecht and A. Salman. A PSO-based End-Member Selection Method for Spectral Unmixing of Multispectral Satellite Images, *Pattern Recognition*, submitted, 2004.
5. M. Omran, A. Engelbrecht amd A. Salman. A PSO-based Color Image Quantizer, *Special issue of Soft Computing Journal in image processing*, submitted, 2004.

Book Chapter:

6. M. Omran, A. Engelbrecht and A. Salman. Image Classification using Particle Swarm Optimization. *Recent Advances in Simulated Evolution and Learning*, K. Tan, M. Lim, X. Yao and L. Wang (Editors), World Scientific, Series on Advances in Natural Computation, 2004.

Conference Publications:

7. M. Omran, A. Salman and A. Engelbrecht. Image Classification using Particle Swarm Optimization. In *Conference on Simulated Evolution and Learning*, Singapore, pp. 370-374, November 2002.