# Hybrid PSO-MOBA for Profit Maximization in Cloud Computing

Dr. Salu George
Assistant Professor
School Of Information Technology
Al Dar University College, Dubai - UAE

***Abstract*—Cloud service provider, infrastructure vendor and clients/Cloud user's are main actors in any cloud enterprise like Amazon web service's cloud or Google's cloud. Now these enterprises take care in infrastructure deployment and cloud services management (IaaS/PaaS/SaaS). Cloud user 's need to provide correct amount of services needed and characteristic of workload in order to avoid over – provisioning of resources and it's the important pricing factor. Cloud service provider need to manage the resources and as well as optimize the resources to maximize the profit. To manage the profit we consider the M/M/m queuing model which manages the queue of job and provide average execution time. Resource Scheduling is one of the main concerns in profit maximization for which we take HYBRID PSO-MOBA as it resolves the global convergence problem, faster convergence, less parameter to tune, easier searching in very large problem spaces and locating the right resource. In HYBRID PSO-MOBA we are combining the features of PSO and MOBA to achieve the benefits of both PSO and MOBA and have greater compatibility.**

***Keywords—Cloud Computing; Profit Maximization; Admission Control; SLA; Optimization; Hybrid Particle Swam Optimization – Multi Objective Bat Algorithm***

## I. INTRODUCTION

Cloud Computing is business enterprise which invests its capital in deployment of infrastructure for developing data centers. Therefore, profit is the main aim of any enterprise and maximizing its profit on the large investment is of the major research contribution in any business. Since cloud computing is going to bring a greater revolution in the real life it needs to concentrate in its gain and sustain in the competitive market by providing computing at low cost without scarifying the quality of service and as well as maximize the cloud service provider 's profit.

Cloud Computing made the dream of computing become true. Cloud computing represents real paradigm shifts in the way in which system are deployed. The massive scale of cloud computing systems was enabled by the popularization of the internet and the growth of some large service companies. Cloud computing makes long-held dream of utility computing possible with a pay-as-you-go, infinitely scalable, universally available system. With cloud computing you can start very small and become big very fast. That's why cloud computing is revolutionary, even if the technology it is built on its evolutionary.

Cloud Computing is business enterprise which invests its capital in deployment of infrastructure for developing data centers. Therefore, profit is the main aim of any enterprise and maximizing its profit on the large investment is of the major research contribution in any business. Since cloud computing is going to bring a greater revolution in the real life it needs to concentrate in its gain and sustain in the competitive market by providing computing at low cost without scarifying the quality of service and as well as maximize the cloud service provider 's profit.

## II. PROFIT MAXIMIZATION IN CLOUD

Profit maximization is a process by which a firm determines the price and output level that returns the maximum profit [3]. Any firm must ensure that it provides the products at cheaper rate along with quality. They should not provide low quality and user satisfaction is important. Cloud computing takes technology, services and application on remote system through Internet, into self service utility. Computing as utility is one of the biggest business today IT is revolving to and apart from providing services at low these firms are interested in gaining the maximum profit on large investments made on datacenter of cloud [6].

We consider Firm's behavior on profit maximization-Firm's scale decision which implies Firm maximizes the profit by considering cost function which minimizes the cost and the optimal quantity of given market prices. Cloud computing as discussed earlier convert's capital expenditure to operational expenditure, and provides on demand access to pool of resources. So, Cloud service providers face many challenges to create successful business apart from which they need to retain profit. Many cloud providers are vague and need to sustain in perfectly competitive cloud computing market and maximize their profit. Cloud computing economics usually considers either SLA agreement or Resource Scheduling policies. In this discussion we consider Infrastructure Vendor, Cloud Service Provider and Customer economic Strategies.

### *A. Profit Maximization Factors*

*1) Infrastructure Vendor:* to retain profit an Infrastructure Vendor's economy of scale should consider:

- Low cost electricity
- High network bandwidth pipes
- Low cost commodity hardware and software.

Apart from the above mentioned it also need to consider the usage pattern, types of request and infrastructure costs [7][20][21][22].

*2) Cloud Service Provider:* A cloud service provider is one who builds the communication model of cloud where infrastructure vendor is cloud storage model. It is responsible for user satisfaction –important feature of any business where cloud provides business agility(maximizes returns by distributed parallel programming), and IT Efficiency(minimize cost through virtualization ).To maximize the profit cloud economies should consider :

- SLA agreement satisfying users and maximizing profit.
- Cost of renting (type of service).
- Configuration of multiserver system.
- Resource scheduling.(profit aware and suitable for distributed parallel computing).[8][9][10][11]

*3) Customer/Cloud User:* Customer should take few responsibilities of

*a) Job should be completed on time with minimum cost.*

*b) Characteristics of application.*

*c) Amount of a service.*

Cloud profit maximization has considered study only on either infrastructure vendor or service provider with any one issue (SLA, Resource Scheduling etc or few of them). But we here put forth all the necessary factors to be considered while maximizing the profit in a cloud[16][17][18][19].

### *B. Measuring Cloud Computing Cost*

An application in cloud computing provides economics of scale commodization of assets, and conformance to programming standards. The cost of a cloud computing deployment is estimated as

$$\mathbf{Cost_{CLOUD}= \sum(UnitCost_{CLOUD}*(Revenue-Cost_{CLOUD}))}$$

where unit cost=cost of a machine instance per hour or another resource[2][3].

Cloud enterprise makes computing not only cheaper but also faster and efficient. Thus, cloud computing takes all the hidden barrier's upon and comforts the end user. The demand thus, is more and it is measured in terms of Compute Unit or CU. It always has expands and shrinks upon the demand , hence Right-sizing is value of proposition in cloud computing cost. The data center needs to be fully utilized and systems being ideal should be utilized rightly to charge effectively and maximum not only returns but maximum returns. Optimization has always been a major concern in any resource utilization and thus our ideas follow them effectively.

Operational cost considers ROI (Returns on investment) as its metrics to calculate Total Cost of Ownership (TCO). Due to cloud flexibility and agility today capital expenditure is converted to operating expenditure [2][3].

Hence, to measure a cloud computing cost:

*1) Customer should provide:*

- Type of service need and levels of services (if required).
- Amount of storage required.

*2) Service Provider:*

- SLA which provides quality of service, satisfaction of customer and penalty charges.
- Risk and Uncertainty.
- Optimized Resource Scheduling.[1]

*3) Infrastructure Vendor:*

- Cost of renting (low cost commodity hardware or software).
- Cost of energy consumption (low cost electricity).
- Cost of network.

### *C. Resource Allocation and Optimization*

Various resource scheduling strategies have been implemented in cloud environment. Proper resource Scheduling is to utilize the resources efficiently. In High Performance Computing where multitenant system is needed optimization is best technique to increases the profit. In cloud demand spikes should be handled in order to sustain inn competitive market among different cloud providers. Cloud computing should therefore optimize resource usage.

Cloud environment uses probabilistic algorithm, Monte-Carlo algorithms of which prominent are 'Ant Colony Optimization', 'Particle Swarm Optimization' and 'Genetic Algorithm.

Cloud for its maximum returns considers many objective such as minimizing cost and optimizing pooled resources in VMs. To rent resources at low cost it has to utilize the resources efficiently. So, we propose Bat intelligence which uses multi objective optimization.

High performance Computing needs parallel programming in distributed environment. Bat Algorithm is proved its global Convergence which is not achieved in any optimization. Thus, this type of resource allocation ensures maximum profit. Our goal is to achieve maximum profit without any sacrificing of services provided by cloud efficiently and effectively [1] [16] [21] [23].

## III. PROPOSED PROFIT MAXIMIZATION FRAMEWORK IN CLOUD COMPUTING

The objective of the project is to maximize the profit in cloud which needs to consider, Resource scheduling, Power consumption model, QOS (Risk and Uncertainty), Optimal speed and Size of servers. In order to overcome these problems proper admission control, resource scheduling and optimal multiserver configuration is to be performed. To maximizing the profit the cloud has to take profit maximization technique which minimizes the cost and optimizes the profit. Therefore Cloud service provider has to manage and optimize the pool of resources along with the cloud user satisfaction and within the given infrastructure to its deployment. Cloud Computing provides computing as a

Utility. Like measuring any other utility (such as electricity, water, etc) computing should only charged as per usage i.e. Pay-as-you-go on basis of cloud.

A job is submitted to cloud by a client. The job or request first enters the queue. To avoid unexpected loss we need to concentrate on risk and uncertainty by controlling the admission of job and finally once the SLA is signed the optimized resource allocation is done which will compute fast with efficient processing. Once the job is assigned to VMs it should start the process and complete as per SLA.

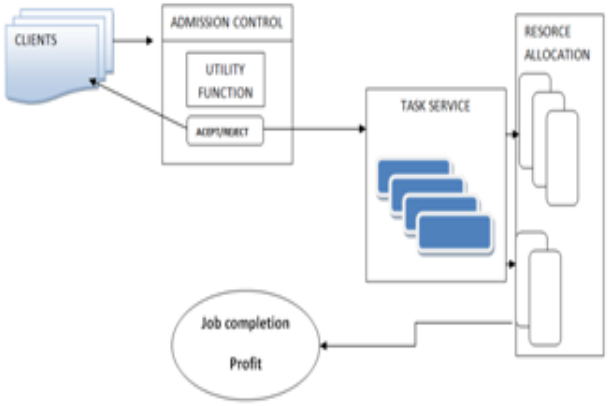


Fig. 1. Proposed Framework for Profit Maximization in Cloud Computing

### A. Profit Aware SLA Specification

In cloud computing SLA is service based as it focuses on characteristics of datacenter and network to support end-to-end communication. If the response time to complete a task is less than specified time in SLA then the service is best and gets its credit. The credit again can be more profit aware if it considers uptime and double the uptime (which implies double the payment i.e. best QOS). But if the response time is longer than the specified time in SLA then penalty is induced (reduce the cost), for low quality of service. And if still it prolongs the response time beyond the limit (waiting to longer) than the cost incurred is zero as per SLA specified. Therefore we usually go with Hard SLA where violation will not reflect profit.

### B. Admission Control

Profit aware cloud considers utility function which is price that the customer is willing to pay. If the job can completed within specified response time than the job is accepted but a service provider is also doing business where gain cannot only relay on admitting possible things but retaining its customers in a competitive cloud market is important as rejection will lead to loss of business. Therefore, a service provider should consider yield function with weight functions of cost minimizing(CPU and time) and trustworthy customer(Cloud Client Register with service provider) to sustain in the market for long (i.e. regular at payments).

### C. HYBRID PSO-MOBA

We propose a HYBRID PSO-MOBA, (Hybrid Particle Swarm Optimization and MultiObjective Bat Algorithm) which combines PSO(Particle Swarm Optimization) and MOBA(MultiObjective Bat Algorithm). PSO search takes place in local space and global updation is done by MOBA. Cloud user submits the job to service provider where we take the probabilistic optimization of all jobs in queue through M/M/m queuing model. Then we take multiobjective resource allocation to services in by MOBA, where the first objective is to consider cloud user's and then client willing to pay double and finally we need to consider the expected service time. The process updates in global search space through MOBA.

Hybrid PSO-MOBA.

***Initialization:***

Initialize a population array of particles with random positions and velocities on *D* dimensions

in the search space.

***Iterative loop:***

For each particle, evaluate the desired optimization fitness function in *D* variables.

Compare particle's fitness evaluation with its *pbesti* . If current value is better than

*pbesti*, then set *pbesti* equal to the current value, and _ *pi* equal to the current location

*_xi* in *D*-dimensional space.

Identify the particle in the neighborhood with the best success so far, and assign its

index to the variable *g*.

***Repeat:***

Change the velocity and position of the particle according to the following equation

_

*_vi* ← *_vi* + _ *U*(0,*φ*1)⊗( _ *pi* − *_xi* )+ _ *U*(0,*φ*2)⊗( _ *pg* − *_xi* ),

*_xi* ← *_xi* + *_vi* .

***Until a complete schedule is constructed***

*Apply MOBA search process*

*Apply the global updating rule*

If a criterion is met (usually a sufficiently good fitness or a maximum number of

iterations), exit loop.

**end loop**

**MOBA search process**

**Objective function $f_1(x)$, …….$f_k(x)$,$x=(x_1,….x_d)^r$**

**Initialize the bat population $x_i(i=1,2,……,n)$ and $v_i$**
For j =1 to N
Generate K weights $w_k>=0$ so that $\sum^K_{k=1} w_{k=1}$
From a single objective $f=\sum^K_{K=1} w_k f_k$
while(t<Max number of iterations)
Generate new solutions and update by (1) to (3)
If(rand>$r_i$)

```
  Random walk around a selected best solution
      End if
      Generate a new solution by flying randomly
     If (rand<A_i&f(x_i) < f(x*))
  Accept the new solutions,
  and increase ri& reduce Ai
end if
     Rank the bats and find the current best x∗
end while
 Record x∗ as a non-dominated solution
end
Postprocess results and visualization
```

Algorithm: Hybrid PSO-MOBA

*1) Cloud user*

Cloud user needs to provide the amount of CPU, memory and time and factors to maximize the profit considered are a) amount of a service (requirement of a service r) and the workload of an application (λ). Cloud user shouldn't request for more resources than needed. Our approach checks for regular cloud customer, service charge (the client is willing to pay) and execution time (within average execution time implies no penalty).

*2) Admission Control*

Admission control is responsible for determining whether it will be profitable for the service provider to accept a job.

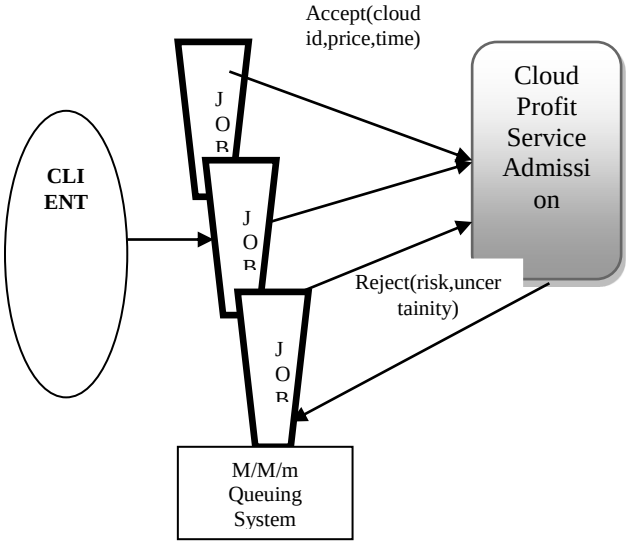


Fig. 2. Admission control flow

Profit-aware control with the time, price, client constraints to utility function. The tupple in utility function is represented by, Utility (risk factor, time, cloud user).Input for the admission control are a) cloud id (regular cloud customer), b) Client willing to pay and c) Expected service time. Output from admission control i.e. the accepted is sent to scheduling and optimization pool and rejected is sent to the user request to be accepted later or released. Advantage of Admiting process is it makes scheduling easier and profitable (economical oriented).

*3) Resource scheduling*

Appropriate resource Scheduling is necessary to configure a multiserver system. We consider scheduling as NP Hard problem and select the best scheduler algorithm micro bat algorithm. We propose a profit aware bat algorithm which optimizes the resource allocation depending upon the service charge and business cost .Since bat algorithm is the only algorithm which has good performance of global convergence property. Input given is the independent jobs with priority which to complete first depending upon admission. To obtain the best optimized resource allocation we have HYBRID PSO-MOBA.

*4) To maximize the profit*

When the server size is small the waiting time of the request is long also gain and the service charge is low. If the server size increases the waiting time will become decreased also the service charge and the gain are increased. It is also applicable to the speed of the server. Waiting time of the request is increased, gain and the service charge is decreased when the server speed is low. Waiting time of the request is decreased, gain and the service charge is increased when the speed of the server is high. Cloud service provider manages the multiserver System through M/M/m Queuing System and optimizes the resource using Hybrid PSO-MOBA. Resource allocation according to admission control and profit aware SLA. To Provide efficient multiserver (powerful) than more servers as it will increase cost of renting and power consumption. General purpose optimization algorithms are simply not suitable for solving this kind of puzzle. EA Scheduling proprietary algorithms, coupled with advanced heuristics, deliver highly optimized schedules blisteringly fast—even for the largest and most complex scheduling problems.

### *D. ADVANTAGES*

Service provider allocates resources and schedules tasks in such a way that the total profit earned is maximized. Our methodology can be applied to other pricing models. The cost of the service is also reduced. Managing Multiserver through M/M/m Queuing model will provided efficient resource management. Optimizing Resources through MOBA will achieve Faster Global convergence. This effective resource optimization will lead to best utilization of resources and as well as Effective and powerful server which ultimately maximizes the profit.

## IV. CONCLUSION AND FUTURE ENHANCEMENT

Optimization of cost model, agility and scales are primary value proposition of adopting a cloud computing based on pay by use, scalable infrastructure and platform services. Organization need to analyze their application portfolio to profile applications which would be adaptable for cloud computing models. The Cloud infrastructure once setup is business investment which needs to return maximum profit over the time period for which we need to consider mainly low power consumption, high performance computing, optimized resource allocation with SLA policy satisfaction.

In future, we need to develop different factors of VM allocation, energy efficiency, different levels of service, and cost of network. We need to develop individual factor based

profit system, but considering all factors ensures no loss in business, which itself ultimately leads to profit. A perfect framework with all the factors with market oriented approach is to be enhanced.

## REFERENCES


[1] R.RAJU ,M.Kalaiarasi, "Profit Maximization in Cloud Computing", accepted for presentation and as well as publication in IEEE digital library,at IEEE- International Conference on Information Communication and Embedded Systems "ICICES-2014".

[2] M. Armbrust et al., "Above the Clouds: A Berkeley View of Cloud Computing," Technical Report No. UCB/EECS-2009-28, Feb. 2009.

[3] Barrie Sosinky,"Cloud Computing Bible",Wiely publication,2011.

[4] http://www.infoworld.com/d/cloud-computing/when-it-makes-sense-become-cloud-provider

[5] http://en.wikipedia.org/wiki/Profit_maximization,2013.

[6] http://home.uchicago.edu/~vlima/courses/econ201/pricetext/ProfMax.pdf.

[7] Calheiros, R.N. , Thulasiram, R.K. ,Buyya et al, "Resource Provisioning Policies to Increase IaaS Provider's Profit in a Federated Cloud Environment", High Performance Computing and Communications (HPCC), 2011 IEEE 13th International Conference.

[8] Hyun Jin Moon, Yun Chi, Hakan Hacigumus, "SLA-Aware Profit Optimization in Cloud Services via Resource Scheduling", IEEE 6th World Congress on Services, 2010.

[9] Linlin Wu , Saurabh Kumar Garg, RajkumarBuyya," SLA-based admission control for a Software-as-a-Service provider in Cloud computing environments", Journal of Computer and System Sciences vol. 78,pp.1280–1299,2012.

[10] K. Xiong, H. Perros, "SLA-based resource allocation in cluster computing systems, ": Proceedings of 17th IEEE International Symposium on Parallel andDistributed Processing (IPDPS 2008), Alaska, USA, 2008.

[11] B.N. Chun and D.E. Culler, "User-Centric Performance Analysis of Market-Based Cluster Batch Schedulers," Proc. Second IEEE/ ACM Int'l Symp.Cluster Computing and the Grid, 2002.

[12] Durkee, "Why Cloud Computing Will Never be Free," Comm. ACM, vol. 53, no. 5, pp. 62-69, 2010.

[13] R. Ghosh, K.S. Trivedi, V.K. Naik, and D.S. Kim, "End-to-End Performability Analysis for Infrastructure-as-a-Service Cloud: An Interacting Stochastic Models Approach," Proc. 16th IEEE Pacific Rim Int'l Symp. Dependable Computing, pp. 125-132, 2010.

[14] K. Hwang, G.C. Fox, and J.J. Dongarra, Distributed and Cloud Computing. Morgan Kaufmann, 2012.

[15] D.E. Irwin, L.E. Grit, and J.S. Chase, "Balancing Risk and Reward in a Market-Based Task Service," Proc. 13th IEEE Int'l Symp. High Performance Distributed Computing, pp. 160-169, 2004.

[16] Y.C. Lee, C. Wang, A.Y. Zomaya, and B.B. Zhou, "Profit-Driven Service Request Scheduling in Clouds," Proc. 10th IEEE/ACM Int'l Conf. Cluster, Cloud and Grid Computing, pp. 15-24, 2010.

[17] F.I. Popovici and J. Wilkes, "Profitable Services in an Uncertain World," Proc. ACM/IEEE Conf. Supercomputing, 2005.

[18] J. Sherwani, N. Ali, N. Lotia, Z. Hayat, and R. Buyya, "Libra: A Computational Economy-Based Job Scheduling System for Clusters, "Software - Practice and Experience, vol. 34, pp. 573-590, 2004.

[19] C.S. Yeo and R. Buyya, "A Taxonomy of Market-Based Resource Management Systems for Utility-Driven Cluster Computing," Software - Practice and Experience, vol. 36, pp. 1381-1419, 2006.

[20] A.P. Chandrakasan, S. Sheng, and R.W. Brodersen, "Low-Power CMOS Digital Design," IEEE J. Solid-State Circuits, vol. 27, no. 4, pp. 473-484, Apr. 1992.

[21] K. Li, "Optimal Load Distribution for Multiple Heterogeneous Blade Servers in a Cloud Computing Environment," Proc. 25th IEEE Int'l Parallel and Distributed Processing Symp. Workshops, pp. 943-952, May 2011.

[22] K. Li, "Optimal Configuration of a Multicore Server Processor for Managing the Power and Performance Tradeoff," J. Supercomputing, vol. 61, no. 1, pp. 189-214, 2012.

[23] P. Mell and T. Grance, "The NIST Definition of Cloud Computing," Nat'l Inst. of Standards and Technology, http://csrc.nist.gov/groups/SNS/cloud-computing/, 2009.

[24] B. Zhai, D. Blaauw, D. Sylvester, and K. Flautner, "Theoretical and Practical Limits of Dynamic Voltage Scaling," Proc. 41st Design Automation Conf., pp. 868-873, 2004.

[25] Yang, X. S.," Bat Algorithm for Multiobjective Optimization", Int. J. Bio-Inspired Computation, Vol.3, No.5, pp.267-274,2011.

[26] T. B¨ack, U. Hammel, and H.-P.Schwefel. Evolutionary computation: Comments on the history and current state. *IEEE Transactions on Evolutionary Computation*, 1(1):3–17, 1997.

[27] S. Bleuler, M. Brack, L. Thiele, and E. Zitzler.Multiobjective genetic programming:Reducing bloat by using SPEA2. In *Congress on Evolutionary Computation (CEC-2001)*, pages 536–543, Piscataway, NJ, 2001. IEEE.

[28] C. A. CoelloCoello, D. A. Van Veldhuizen, and G. B. Lamont.*Evolutionary Algorithms for Solving Multi-Objective Problems*. Kluwer, New York, 2002.

[29] D. W. Corne, J. D. Knowles, and M. J. Oates. The pareto envelope-based selection algorithm for multiobjective optimisation. In M. Schoenauer et al., editors, *ParallelProblem Solving from Nature (PPSN VI)*, pages 839–848, Berlin, 2000. Springer.

[30] M. P. Fourman. Compaction of symbolic layout using genetic algorithms. In J. J.Grefenstette, editor, *Proceedings of an International Conference on Genetic Algorithms and Their Applications*, pages 141–153, Pittsburgh, PA, 1985. Sponsored by Texas Instruments and U.S. Navy Center for Applied Research in Artificial Intelligence (NCARAI). Vol. 1993, pages 197–212, Berlin, 2001. Springer.

[31] S. Helbig and D. Pateva. On several concepts for _-efficiency.*OR Spektrum*,16(3):179–186, 1994.

[32] J. Horn, N. Nafpliotis, and D. E. Goldberg. A niched pareto genetic algorithm for multiobjective optimization. In *Proceedings of the First IEEE Conference on Evolutionary Computation, IEEEWorld Congress on Computational Computation*, volume 1, pages 82–87, Piscataway, NJ, 1994. IEEE Press.

[33] H. Ishibuchi and T. Murata.Multi-objective genetic local search algorithm. In *Proceedings of 1996 IEEE International Conference on Evolutionary Computation(ICEC'96)*, pages 119–124, Piscataway, NJ, 1996. IEEE Press.

[34] J. D. Knowles and D. W. Corne. The pareto archived evolution strategy: A new baseline algorithm for paretomultiobjective optimisation. In *Congress on Evolutionary Computation (CEC99)*, volume 1, pages 98–105, Piscataway, NJ, 1999.IEEE Press.

[35] F. Kursawe. A variant of evolution strategies for vector optimization.In H.-P.Schwefel and R. M¨anner, editors, *Parallel Problem Solving from Nature*, pages193–197, Berlin, 1991.Springer.

[36] G. Rudolph. *Convergence Properties of Evolutionary Algorithms*.VerlagDr.Kova˘c, Hamburg, 1997.

[37] G. Rudolph. Evolutionary search for minimal elements in partially ordered sets. In *Evolutionary Programming VII – Proc. Seventh Annual Conf. on Evolutionary Programming (EP-98)*, San Diego CA, 1998.The MIT Press, Cambridge MA.