A Virtual Machine Placement Taxonomy

Fabio L´opez Pires
Itaipu Technological Park (PTI)
National University of Asunci´on (UNA)
fabio.lopez@pti.org.py
Paraguay

Benjam´ın Bar´an
National University of Asunci´on (UNA)
East National University (UNE)
bbaran@pol.una.py
Paraguay

Introduction

- Cloud computing datacenters deliver infrastructure (IaaS), platform (PaaS) and software (SaaS) as services
- Present work : Efficient management of PM & VM
- VMP : selecting which VM should be hosted at each PM
- No public research work presenting a general study of the VMP literature.

Virtual Machine Placement Taxonomy

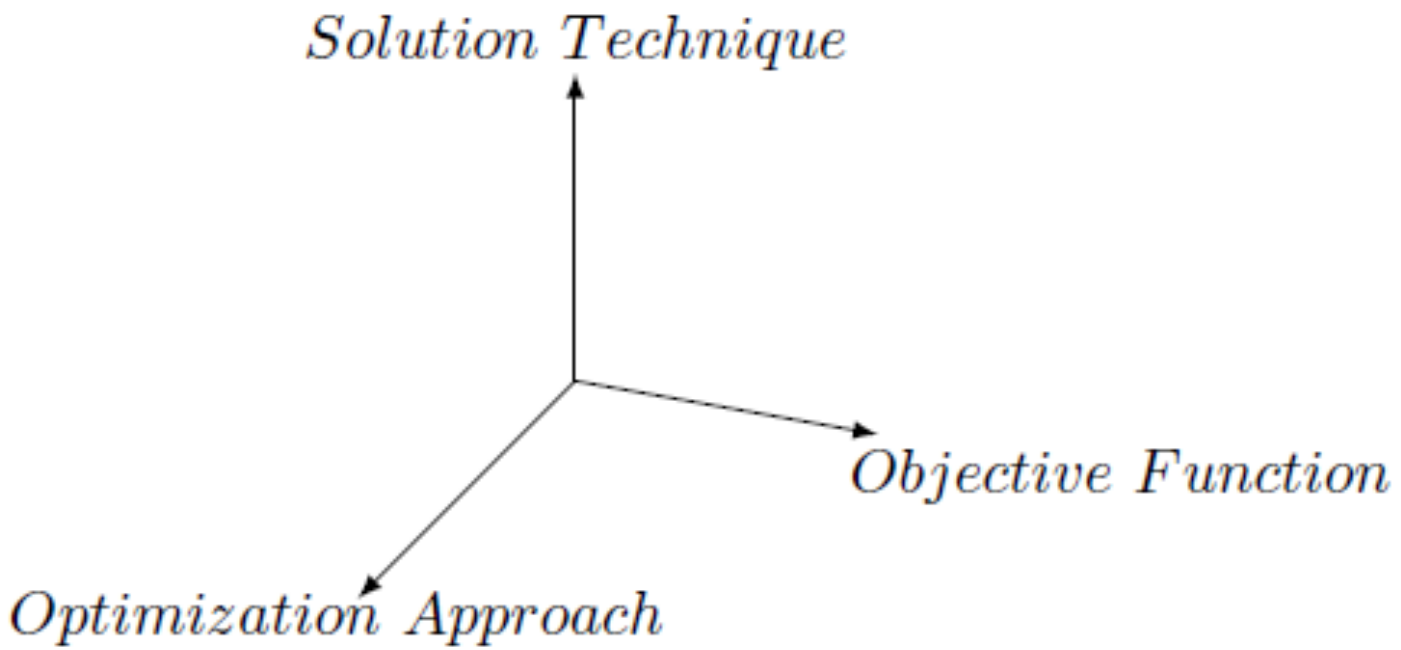


Figure 1. Main classification criteria for the proposed VMP taxonomy

Objective Function

Table I
OBJECTIVE FUNCTIONS: A PAPER MAY CONSIDER JUST ONE OR SEVERAL DIFFERENT OBJECTIVE FUNCTIONS.

Objective Function	**% of studied papers**
Energy Consumption Minimization	51.2%
Network Traffic Minimization	30.9%
Economical Revenue Maximization	22.6%
Performance Maximization	16.7%
Resource Utilization Maximization	15.5%

Objective Function

- Energy Consumption Minimization
- Network Traffic Minimization
  - Network communication cost
  - Live migration overhead
  - Network metrics : delay, network performance……

$$P(U_{cpu}) = U_{idle} \times P_{max} + (1 - U_{idle}) \times P_{max} \times U_{cpu} \quad (5)$$

where:

$P(U_{cpu})$: Power consumption of a PM
U_{idle}: Fraction of power consumed by an idle PM
P_{max}: Maximum power consumption of a PM
U_{cpu}: CPU utilization rate

$$E = \int_{t_0}^{t_1} P(U_{cpu}(t))\, dt \quad (6)$$

Optimization Approaches

- Mono-Objective Approach
- Multi-Objective solved as Mono-Objective Approach
  - Weight sum
  - linear combination
- Pure Multi-Objective Approach

Optimize:

$$y = f(x) = [f_1(x), f_2(x), ..., f_q(x)] \quad (1)$$

subject to:

$$e(x) = [e_1(x), e_2(x), ..., e_r(x)] \geq 0 \quad (2)$$

where:

$$x = [x_1, x_2, ..., x_p] \in X \quad (3)$$

$$y = [y_1, y_2, ..., y_q] \in Y \quad (4)$$

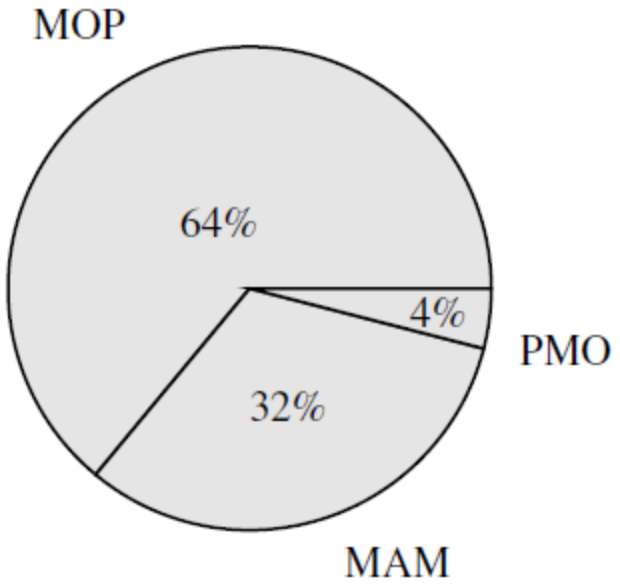


Figure 2. Percentage of articles considering each optimization approach in the studied universe of 84 papers.

Solution Techniques

Table II
SOLUTION TECHNIQUES: IT COULD APPLIED MORE THAN ONE.

Solution Technique	**% of studied papers**
Deterministic Algorithms	17.9%
Heuristics	66.7%
Meta-Heuristics	14.3%
Approximation Algorithms	2.4%

Solution Techniques

- Deterministic Algorithm
- Heuristics
- Meta-Heuristics

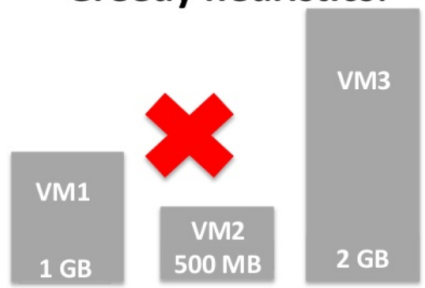
$$N = (n+1)^m$$

where:

N:	Size of the searching universe
n:	Number of physical machines
m:	Number of virtual machines

2. Bin Packing

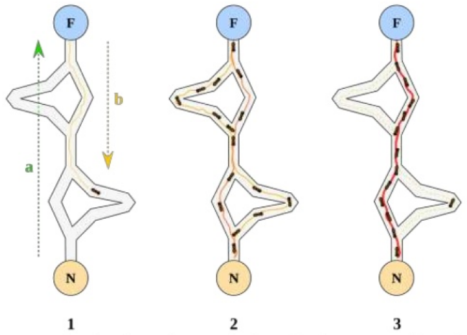
Greedy heuristics:



- First-Fit (FF)
- First-Fit Decreasing (FFD)
- Best-Fit (BF)
- Best-Fit Decreasing (BFD)
- ...

2. Bin Packing

Ant Colony Optimization (ACO) heuristics:



- Ant System (AS)
- Ant Colony System (ACS)
- Min-Max Ant System (MMAS)

Source: upload.wikimedia.org/wikipedia/commons/thumb/a/af/Aco_branches.svg/2000px-Aco_branches.svg.png

Conclusion

- There is no optimization problem with more than 3 objective function
- Holistic energy models
- Live migration network overhead
- There is no PMO deterministic, heuristic algo and performance

Q&A

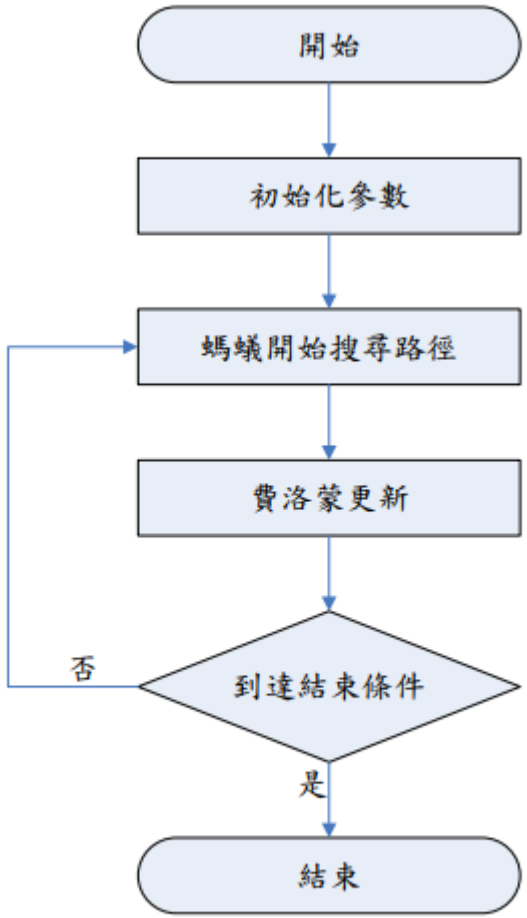


圖 3 蟻群最佳化流程圖