Description of PBFVMC Benchmarks for Pseudo-Boolean Evaluation 2015

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1 Introduction

PBFVMC stands for Pseudo-Boolean Formulation to Virtual-Machine Consolidation. This formulation was described in BRACIS 2013 paper [1] as an enhancement of a previous Pseudo-Boolean formulation published in IBERAMIA 2012 [2].

Section 2 recall how PBFVMC is generated and section 3 explains what are the size and the available formulae.

2 PBFVMC

PBFVMC formulation contains the following variables:

- N : Total number of available hardware (hw);

- K : Total number of virtual machines (VM);

- hw_i : Hardware $i \in N$;

- $vm_j^{hw_i}$: Virtual Machine $j \in K$ that runs in hw_i;

A hardware is considered ON when hw_i is *True*, otherwise it is OFF.

Constraints are defined as follows:

$$minimize : \sum_{i=1}^{N} hw_i \tag{1}$$

$$\sum_{i=1}^{N} R_{hw_i} \cdot hw_i \geq \sum_{j=1}^{K} R_{vm_j} \tag{2}$$

$$\sum_{i=1}^{N} P_{hw_i} \cdot hw_i \geq \sum_{j=1}^{K} P_{vm_j} \tag{3}$$

$$\forall i \in 1..N \left(\sum_{j=1}^{K} (R_{vm_j} \cdot \neg vm_j^{hw_i}) + R_{hw_i} \cdot hw_i \geq \sum_{j=1}^{K} R_{vm_j} \right) \tag{4}$$

$$\forall i \in 1..N \left(\sum_{j=1}^{K} (P_{vm_j} \cdot \neg vm_j^{hw_i}) + P_{hw_i} \cdot hw_i \geq \sum_{j=1}^{K} P_{vm_j} \right) \tag{5}$$

$$\forall j \in 1..K \left(\sum_{i=1}^{N} vm_j^{hw_i} \geq 1 \right) \tag{6}$$

$$\forall j \in 1..K \left(\sum_{i=1}^{N} \neg vm_j^{hw_i} \geq N - 1 \right) \tag{7}$$

The objective function is the summation of the ON servers. Inequalities constraints (2) and (3) guarantees that the summation of memory and processing power of the powered ON servers fit the needs to power all virtual machines. Constraints (4) and (5) are the upper limit on the total resources each hardware may provide in relation to the virtual machines that may run on that hardware. Constraint (6) states that a virtual machine must be running in some hardware. Constraint (7) ensures that the virtual machine is running in exactly one hardware.

That formulation generates $(2 + 2 \times N + 2 \times K)$ constraints and $(N + N \times K)$ variables.

3 Benchmark Description

All formulae have been divided in a subset of workloads and hardware. There are formulae for 32, 64, 128, 256 and 512 hardware. For each subset of hardware there are workloads of 25%, 50%, 75%, 85%, 90%, 95%, 98%, 99%, 100% and 110%, being the 110% always UNSAT.

For the Pseudo-Boolean Evaluation 2015 there are a total of 60 formulae available, being 30 for the optimization track and 30 for the decision track. For the optimization track all formulae are from 32,64 and 128 hardware subset. For the decision track all formulae are from 128, 256 and 512 hardware subset.

The only difference from the optimization and decision formulae are that the decision has the objective function omitted.

Table 1 shows the size of all formulae concerning the amount of variable and constraints for all subsets of hardware and workload.

References

[1] B. C. Ribas, R. M. Suguimoto, R. A. M. no, F. Silva, and M. A. Castilho, "Pbfvmc: A new pseudo-boolean formulation to virtual-machine consolidation," in *BRACIS 2013*, ser. IEEE, A. Pozo, Ed., vol. 7637. IEEE, 2013, pp. 361–370.

[2] B. C. Ribas, R. M. Suguimoto, R. A. M. no, F. Silva, L. de Bona, and M. A. Castilho, "On modelling virtual machine consolidation to pseudo-boolean constraints," in *Advances in Artificial Intelligence – IBERAMIA 2012*, ser. Lecture Notes in Computer Science, J. Pavón, N. D. Duque-Méndez, and R. Fuentes-Fernández, Eds., vol. 7637. Springer, 2012, pp. 361–370.

Table 1: Comparison of the size of the formulas from the previous and PBFVMC formulation to the problem. Table shows workloads of 25%, 50%, 75%, 85%, 90%, 95%, 98%, 99%, 100% and 110% for the subsets of 32, 64, 128, 256 and 512 hardware.

HW	VMS	Vars	Constr	HW	VMS	Vars	Constr
hw32-vm25p	164	3168	262	hw64-vm25p	304	11200	478
hw32-vm50p	239	5568	412	hw64-vm50p	501	23808	872
hw32-vm75p	344	8928	622	hw64-vm75p	689	35840	1248
hw32-vm85p	386	10272	706	hw64-vm85p	759	40320	1388
hw32-vm90p	391	10432	716	hw64-vm90p	795	42624	1460
hw32-vm95p	414	11168	762	hw64-vm95p	837	45312	1544
hw32-vm98p	430	11680	794	hw64-vm98p	842	45632	1554
hw32-vm99p	432	11744	798	hw64-vm99p	843	45696	1556
hw32-vm100p	434	11808	802	hw64-vm100p	844	45760	1558
hw32-vm110p	462	12704	858	hw64-vm110p	896	49088	1662
HW	VMS	Vars	Constr	HW	VMS	Vars	Constr
hw128-vm25p	626	47232	994	hw256-vm25p	1226	182528	1938
hw128-vm50p	971	91392	1684	hw256-vm50p	1921	360448	3328
hw128-vm75p	1306	134272	2354	hw256-vm75p	2633	542720	4752
hw128-vm85p	1413	147968	2568	hw256-vm85p	2886	607488	5258
hw128-vm90p	1535	163584	2812	hw256-vm90p	2994	635136	5474
hw128-vm95p	1579	169216	2900	hw256-vm95p	3097	661504	5680
hw128-vm98p	1626	175232	2994	hw256-vm98p	3133	670720	5752
hw128-vm99p	1668	180608	3078	hw256-vm99p	3192	685824	5870
hw128-vm100p	1681	182272	3104	hw256-vm100p	3222	693504	5930
hw128-vm110p	1823	200448	3388	hw256-vm110p	3460	754432	6406

HW	VMS	Vars	Constr
hw512-vm25p	2458	733696	3890
hw512-vm50p	3797	1419264	6568
hw512-vm75p	5061	2066432	9096
hw512-vm85p	5457	2269184	9888
hw512-vm90p	5771	2429952	10516
hw512-vm95p	6094	2595328	11162
hw512-vm98p	6345	2723840	11664
hw512-vm99p	6428	2766336	11830
hw512-vm100p	6438	2771456	11850
hw512-vm110p	6898	3006976	12770